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July 31, 1972

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Volume 26, Number 14, July 31, 1972

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary
  alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140
  (AAEC/LIB/Bib-254)

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    25:40 (IDO-12073, pp 28-36)
  separation by ion exchange and complex-formation elution,
    25:251(P)

TRIETHYLENETETRAMINE
  complexes with cobalt(III) and rhodium(III) chlorides,
    radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
  content in Cattaraugus Creek near West Valley Processing
    Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
  content in Cattaraugus Creek near West Valley Processing
    Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
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    counting, 25:40 (IDO-12073, pp 28-36)

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372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

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Use of funds for printing this publication approved by the Director of the Office of Management and Budget, June 19, 1972.

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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

33032 (AEC-tr-7102/11-12) NUKLEONIKA. Translation of Nukleonika; 15: No. 11-12, 705-830(1970). 113p. (TT-70-55010/11-12). Dep. NTIS.

Analytical Chemistry

Refer also to abstracts 33554, 33808, and 33845.

33033 (SGAE-CH-77/1972) ANALYSIS FOR URANIUM AND PLUTONIUM IN FUEL MANUFACTURE AND FUELS. Falta, G.; Knotik, K.; Sorantin, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Institut fuer Chemie). [nd]. 11p. Dep. NTIS (U. S. Sales Only).

Analytical work in the Reactor Centre Seibersdorf dealing with unirradiated fuels for high-temperature gas-cooled reactors, (U,Th)C$_2$, UO$_2$, (U,Th)O$_2$ coated with pyrocarbon and pyrocarbon–silicon carbide and with compacted fuels, is briefly reviewed. Newly developed chemical and electrochemical disintegration methods for compacted fuel bodies, separating coated fuel particles from graphite matrices are explained. Some new methods for the pretreatment of coated particles and extraction of the fissile material are discussed. In the last section the determination methods, such as volumetry, polarography, and α counting by liquid scintillation, are described. (auth)

Activation and Nuclear Reaction Procedures

33034 (AD-734380) DETERMINATION OF PICOGRAM AMOUNTS OF TECHNETIUM IN ENVIRONMENTAL SAMPLES BY NEUTRON ACTIVATION ANALYSIS. Final Report, 1963–1970. Foti, S.; Delucchi, E.; Akamian, V. (Naval Ordnance Lab., White Oak, Md.). 23 Sep 1971. 18p. (NOLTR-71-152). NTIS.

A procedure for determination of picogram amounts of ^{99}Tc in filter paper and vegetation samples was developed. The procedure consists of the following major steps: pre-irradiation separation of technetium from the sample and purification of the technetium fraction; thermal neutron irradiation of the ^{99}Tc fraction to produce ^{100}Tc; post-irradiation separation and purification of ^{100}Tc from other activated nuclides; and counting of the 16 sec ^{100}Tc in a low-background beta counter. (auth) (NTIS)

33035 (CONF-710533–, pp 37-47) LOOK AT ON-STREAM ANALYSIS. Presgrave, D. K. (R. T. Z. Services Ltd., London (England)).

From Symposium on automatic control systems in mineral processing plants; Brisbane, Australia (17 May 1971).

The rapid development of on-stream compositional analysis in the mineral industry prompts consideration of the potential value of techniques when a new project is designed. Types of analysers are considered and together with ancillary equipment and techniques of analysis are assessed in relation to their implementation in a design project. The effect of computers on costing is also considered. An attempt is made to establish broad criteria for future plant design. (Australia)

33036 APPLICATION OF ACTIVATION ANALYSIS FOR DETERMINING ALKALINE PHOSPHATASE ACTIVITY IN TETRAHYMENA. Akoboshi, Mitsuhiko; Kawai, Kenichi; Waki, Asako (Kyoto Univ.). Anal. Biochem.; 46: No. 2, 683-7(Apr 1972).

A method is described for determining the alkaline phosphatase activity during growth of Tetrahymena that involves irradiating the reaction mixture on chromatographic paper and determining the radioactivity of ^{32}P (half-life 14.3 days). (D.H.M.)

33037 CHEMICAL STABILITY OF BIOLOGICAL SAMPLES SUBJECTED TO PROTON-REACTION ANALYSIS. Ricci, E. (Oak Ridge National Lab., Tenn.). J. Radioanal. Chem.; 9: No. 2, 273-7(Dec 1971).

The kinetic energy of charged particles is rapidly degraded into large amounts of heat in the target; if biological samples are bombarded, chemical decomposition may result. A simple least-squares straight-line fitting procedure was applied to test the chemical stability of freeze-dried, compressed samples of human lung, brain and E. coli, under bombardment with a 0.33 to 0.48 μA beam of 0.7 MeV protons. The method showed no significant damage in these conditions, and also estimated the maximum length of ''safe'' bombardment to be approximately 50 min. The samples were being subjected to proton-reaction analysis for ratios ^{13}C/^{12}C and N/C when the least-squares test was performed; however, this method may be easily adapted to check— and roughly predict— sample stability in practically any activation, prompt-reaction, or related analysis based on charged-particle bombardment. (auth)

33038 APPLICATION OF NEUTRON ACTIVATION ANALYSIS FOR THE INVESTIGATION OF CONCENTRATION PROFILES IN SILICON. Heinze, W. (Technische Hochschule, Ilmenau, Ger.); Niese, S. Isotopenpraxis; 8: No. 2, 41-7(Feb 1972). (In German).

Activation analysis was successfully applied to concentration profile determinations of doping elements in silicon. Contrary to the measurements of conductivity it gave information on the concentrations of individual elements independent of their valency. In diffusion experiments of phosphorus and gallium in silicon it was found that the diffusion coefficient increases with increasing concentration of the doping elements, or with increasing concentration of the uniformly charged predoping elements. (auth)

33039 NEW METHOD FOR THE RADIOCHEMICAL SEPARATION OF RUBIDIUM AND CESIUM. Pant, D. R.; Parekh, P. P. (Bhabha Atomic Research Centre, Trombay, India). J. Radioanal. Chem.; 9: No. 2, 259-65(Dec 1971).

The analytical reactions of bismuth iodide and stannic chloride with cesium and rubidium are used for the radiochemical separation of these two elements. The method consists in precipitating potassium, rubidium and cesium as their cobaltinitrites, selective isolation of cesium as cesium bismuth iodide from glacial acetic acid, and subsequent separation of rubidium from potassium as chlorostannate from concentrated HCl. The results obtained by the present method for the rubidium and cesium contents of the different U.S.G.S. standard rock samples are compared with those reported using methods of comparable accuracy. The suitability of the method for the analysis of fallout samples for their radiocesium (^{137}Cs) contents was demonstrated. (auth)

33040 DETERMINATION OF TRACE ELEMENTS IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION AND EXTRACTION WITH TOPO. Steinnes, E.; Birkelund, O. R.; Johansen, O. (Institutt for Atomenergi, Kjeller, Norway). J. Radioanal. Chem.; 9: No. 2, 267-72(Dec 1971).

Solvent extraction with TOPO from 6M hydrochloric acid is proposed as a method for the elimination of interfering activities in neutron activation analysis of biological material for trace elements. By this procedure ^{24}Na, ^{42}K, ^{32}P, ^{82}Br, and ^{47}Ca are efficiently removed, and a number of trace element activities can be measured by Ge(Li) spectrometry. Chemical yields are determined by re-activation. Data for Cu, Zn, Mo, and Cd in two biological standards are presented. (auth)

33041 ACCOUNTING FOR FLUX DECREASE IN NEUTRON ACTIVATION ANALYSIS. Damburg, N. A.; Pelekis, L. L.; Protasova, L. F. (Inst. of Physics, Riga). J. Radioanal. Chem.; 9: No. 2, 329-39(Dec 1971).

The problem of neutron flux decrease during the activation of samples is discussed. Data by different authors on the weight of spherical samples corresponding to a flux decrease of 10% are reported. The self-shielding effect due to the presence of constituents with large absorption cross-sections is discussed. (auth)

33042 DETERMINATION OF THERMAL AND EPITHERMAL NEUTRON FLUXES WITH A SINGLE FLUX MONITOR. Maenhaut, W.; Adams, F.; Hoste, J. (Univ., Ghent). J. Radioanal. Chem.; 9: No. 2, 325-8(Dec 1971).

Two methods are described for determining the thermal and epithermal neutron fluxes with a single flux monitor. The use of one single flux monitor is sufficient to determine ϕ_{epi}/ϕ_{th} ratios and has advantages compared with the triple comparator method. Errors due to flux gradients for instance are completely eliminated in both of the methods described. The second method allows the elimination of the errors mentioned, but has the disadvantage that only the ratio ϕ_{epi}/ϕ_{th} can be determined. However, to perform activation analyses, a knowledge of this ratio is sufficient and if absolute neutron fluxes have to be known, a second monitor can be co-irradiated. (D.H.M.)

33043 DETERMINATION OF OXYGEN IN STEELS BY 14 MeV NEUTRON ACTIVATION ANALYSIS. Sterlinski, Slawomir; Golian, Cezary (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw); 16: No. 5, 1101-20(1971). (In Polish).

The nuclear reaction ^{16}O(n,p)^{16}N was used for the determination of oxygen in steels. Steel samples were transferred by means of single-channel pneumatic system. To achieve isotropic irradiation the technique of spinning sample during activation was used. The irradiation, transfer, and counting sequence may be automatically controlled. For normalization of the sample activation the standard fast-neutron monitoring system was applied. An ordinary cylindrical 3″ × 3″ NaI(Tl) scintillation detector was used for counting. The limit of oxygen detection for 15 g steel sample is 10 ppM and limit of determination 55 ppM, respectively. Relative standard deviation amounted to 30, 10, and 6% for the oxygen concentration levels of 10, 100, and 4000 ppM, respectively. An "apparatus error" was found to be 5.5%. Typical analysis of the sample containing about 100 ppM of oxygen requires approximately 2 minutes of experimental time. (auth)

33044 SUBSTOICHIOMETRIC DETERMINATION OF MERCURY BY NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). J. Radioanal. Chem.; 10: No. 2, 181-6(Apr 1972).

A method was developed for substoichiometric determination of mercury by thermal neutron activation analysis, based on selective extraction of the Hg(II)-Bindschedler's Green complex into 1,2-dichloroethane. The method was applied for the determination of trace amounts of mercury in geological standards such as W-1, GR, Sye-1, and T-1, meteorite Allende de Publito, and biological materials such as kale, Ir1 standard tobacco, and human blood serum. (auth)

33045 APPLICATION OF TRI-n-OCTYLAMINE FOR THE SUBSTOICHIOMETRIC SEPARATION OF CHROMIUM(VI) IN ACTIVATION ANALYSIS. Zmijewska, W. (Inst. of Nuclear Research, Warsaw). J. Radioanal. Chem.; 10: No. 2, 187-96(Apr 1972).

A method was developed for the substoichiometric separation of Cr(VI) by extraction with tri-n-octylamine solution in benzene from 0.1 M H_2SO_4 solution. The method was applied to the determination of chromium in silicon and aluminum by neutron activation. (auth)

33046 DETERMINATION OF OXYGEN IN MOLYBDENUM BY MEANS OF ALPHA PARTICLES. Faure, L.; Boissier, M.; Tousset, J. (Univ. Claude Bernard de Lyon, Villeurbanne, France). J. Radioanal. Chem.; 10: No. 2, 213-23(Apr 1972). (In French).

The determination of oxygen in molybdenum by means of α activation analysis is described. The separation of fluorine is performed by extraction with diphenyldichlorosilane. The results concerning oxygen surface concentrations, determined using nuclear reactions induced by low-energy deuterons, are reviewed. (auth)

33047 DETERMINATION OF OXYGEN IN LEAD AND LEAD ANTIMONY BY MEANS OF ALPHA PARTICLES. Faure, L.; Giroux, J.; Tousset, J. (Univ. Claude Bernard de Lyon, Villeurbanne, France). J. Radioanal. Chem.; 10: No. 2, 223-33(Apr 1972). (In French).

The determination of oxygen in lead and in lead-antimony by means of α-activation analysis is described. The separation of fluorine resulting from irradiation of oxygen is performed by extraction with diphenyldichlorosilane, in isopropyl ether. In the case of lead-antimony alloy, a more complex separation scheme of fluorine from iodine resulting from irradiation of antimony is described. (auth)

33048 NEUTRON ACTIVATION ANALYSIS FOR OSMIUM AND RUTHENIUM IN PLATINUM. Payton, G. J.; Martin, D. S. Jr. (Ames Lab., Iowa). J. Radioanal. Chem.; 10: No. 2, 235-43(Apr 1972).

A sensitive procedure for the simultaneous determination of trace levels of osmium and ruthenium in platinum, by thermal neutron activation analysis utilizing γ spectrometry, was developed. The radiochemical separation method utilized perchloric acid for a selective oxidation of osmium and ruthenium to the volatile tetroxides. The distillation of the tetroxides greatly reduced the radiation hazard presented by the bulk of the activities in the matrix. Activities of 15-day ^{191}Os and 40-day ^{103}Ru were measured by accumulation of pulses from a 3″ diameter NaI(Tl) crystal detector. Analyses of γ spectra were achieved using digital computer techniques. The procedure provided analyses for a high-purity platinum stock of 0.032 ± 0.007 ppM Os and 0.044 ± 0.005 ppM Ru. (auth)

33049 USE OF THE NATIONAL PHYSICAL LABORATORY IONIZATION CHAMBER TYPE 1383A IN NEUTRON ACTIVATION ANALYSIS. Heydorn, K. (Danish Atomic Energy Commission Research Establishment, Roskilde). J. Radioanal. Chem.; 10: No. 2, 245-56(Apr 1972).

The National Physical Laboratory γ-ionization chamber was used for the measurement of chemical yield by re-irradiation in a method for the determination of arsenic by neutron activation. Satisfactory accuracy and a precision of 1% were obtained with a single reading. Discrimination against other radioisotopes is achieved by irradiating for a short time and measuring at a total decay time of one mean life of the radionuclide to be determined; the resulting discrimination factor is given as a function of the half-life ratio. Maximum sensitivities for 66 elements with γ-emitting thermal neutron capture products were calculated for irradiation and decay times both equal to one half-life, and it is shown that the sensitivity for shorter irradiations at the selected time of measurement is a linear function of the irradiation time. More than a dozen elements were found suitable for determination at the milligram level by neutron activation followed by γ-ionization chamber measurement. The error from interfering elements can be directly estimated from their expected concentrations by means of the calculated sensitivities and discrimination factors presented. (auth)

33050 METHOD OF MEASUREMENT OF THE PERIOD OF A RADIOACTIVE BODY OF SHORT LIFE. APPLICATION TO ^{179m}Hf AND ^{46m}Sc. Beeler, R.; Balsenc, L.; Laplace, J. (Univ., Geneva). J. Radioanal. Chem.; 10: No. 2, 257-66(Apr 1972). (In French).

The decay curve of short-lived radioisotopes (T < 1 min), if registered by a multichannel analyzer in multiscaler mode, does not remain exponential when the counting rate increases. A method for adjusting experimental values by the maximum of likelihood function is proposed. It includes the determination of initial dead-time fraction. The half-lives of ^{179m}Hf and ^{46m}Sc determined by the present method show a good concordance with table data, for initial dead time fractions as high as 80%. (auth)

33051 CONTINUOUS NEUTRON ACTIVATION ANALYSIS. Kliment, V.; Toelgyessy, J. (Inst. of Physics, Bratislava. Technical Univ., Bratislava). J. Radioanal. Chem.; 10: No. 2, 273-97 (Apr 1972).

Neutron activation techniques for on-stream analysis are reviewed. Topics covered include: neutron sources, activation chambers, connecting tubing, counting chambers, detectors, optimum flow rate of the solution, sensitivity of continuous activation analysis, interfering nuclear reactions, and applications. (M.C.G.)

33052 COMPUTER PROGRAM IN ALGOL-60 FOR THE LOCATION AND EVALUATION OF PEAKS IN Ge(Li) GAMMA RAY SPECTRA. Verheijke, M. L. (Philips Research Labs., Eindhoven, Netherlands). J. Radioanal. Chem.; 10: No. 2, 299-314(Apr 1972).

A program is presented for the analysis of γ spectra from Ge(Li) multichannel spectrometer systems. The program is written in ALGOL-60 for off-line working with a large Philips Electrologica X8 computer. It has been extensively used in thermal neutron activation analysis practice. (auth)

33053 TABLES OF GAMMA RAYS EMITTED BY RADIONUCLIDES PRODUCED THROUGH PHOTONUCLEAR REACTIONS. Galatanu, V.; Grecescu, M. (Inst. for Atomic Physics, Bucharest). J. Radioanal. Chem.; 10: No. 2, 315-32(Apr 1972).

The tables were prepared as an auxiliary for the interpretation of results in photoactivation analysis. They include data concerning the disintegration of radionuclides produced by (γ,n) reactions on all stable isotopes with a relative abundance greater than 1% and by (γ,p) reactions on elements with $Z \leq 39$. The γ rays are listed in ascending order of the energies; half-lives, intensities, and other useful information are also included. (auth)

33054 NEUTRON-ACTIVATION DETERMINATION OF VANADIUM IN OILS AND CATALYSTS. Arroyo, Alfredo; Brune, Dag (Instituto de Asuntos Nucleares, Bogota). Mikrochim. Acta; No. 2, 239-41(1972).

Vanadium in crude and residual oils and in catalysts at concentration levels of 0.2 to 200 and 400 to 2000 ppM, respectively, was determined by means of neutron activation analysis based on measurement of the nuclide ^{52}V. The aim was to apply the technique to industrial or general routine analysis. Four samples were analyzed simultaneously in less than 15 minutes. (auth)

33055 PROTEIN DETERMINATION BY NEUTRON ACTIVATION ANALYSIS. Wood, D. E. (Kaman Sciences Corp., Colorado Springs, Colo.). Isotop. Radiat. Technol.; 9: No. 3, 351-3 (Spring 1972).

Protein in foodstuffs can be determined by neutron activation of the nitrogen and counting of the resulting gamma radiation. An instrument for automatic, nondestructive analysis of samples, which has been field tested and is commercially available, is described. This is an updating of Report KN-69-270(R), 1969. (auth)

33056 RAPID, QUANTITATIVE SEPARATION FOR THE DETERMINATION OF SELENIUM USING NEUTRON ACTIVATION ANALYSIS. Rook, Harry L. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 44: No. 7, 1276-8 (Jun 1972).

A method for separation of volatile elements, originally developed for mercury, was studied and adapted to the selenium problem. The procedure has a minimum of chemical manipulations, the radioselenium separation is quantitative, the procedure is based on a physical separation, and mercury can be determined simultaneously. (M.C.G.)

33057 DETERMINATION OF SUBMICROGRAM AMOUNTS OF BORON USING THE ^{10}B(n,α)^{7}Li REACTION. Lelental, Mark (Eastman Kodak Co., Rochester, N. Y.). Anal. Chem.; 44: No. 7, 1270-2(Jun 1972).

Low sensitivity of analyses based on the ^{10}B(n,α)Li reaction can be avoided by registering radioactivity resulting from the reaction during the process of irradiation. A particle track method of alpha detection was used. The sensitivity was largely determined by the interaction of fast neutrons with the plastic detector. The limit of quantitative boron determination is estimated to be 3.8×10^{-10} g B/cm^2. (M.C.G.)

33058 STUDY OF GAMMA-RAY SPECTRUM DISTORTION BY MATHEMATICAL SMOOTHING. Yule, Herbert P. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 44: No. 7, 1245-9(Jun 1972).

Removal of statistical scatter from gamma spectra is a considerable aid in the computerized reduction of spectral data. Application of mathematical filters to the data may result in erroneous results due to distortion introduced by the filter. Such distortion is often difficult to detect and even more difficult to measure. Repeated filtering, or smoothing, was applied to different spectral situations to obtain indications of the amount of distortions introduced by smoothing. It was concluded that filtering one time, the usual number of smoothings, introduces little distortion in most cases, although overlapping peaks may suffer some distortion. (auth)

33059 METHOD FOR DETERMINATION OF MERCURY IN BIOLOGICAL MATERIALS BY NEUTRON ACTIVATION ANALYSIS. Rook, Harry L.; Gills, Thomas E.; LaFleur, Philip D. (National Bureau of Standards, Washington, D. C.). Anal. Chem.; 44: No. 7, 1114-17(Jun 1972).

A method is described for determination of mercury in a variety of matrices. Three significant improvements over currently used procedures were achieved: The procedure has a minimum of chemical manipulations, thereby minimizing technique-related errors; the radiomercury separation is quantitative, thus eliminating unnecessary errors involved in the determination of chemical yields; the procedure is based on a simple combustion separation of radiomercury allowing the same technique to be used on a wide variety of matrices. The method was tested using radiotracer experiments and by analyzing samples of flour and coal that had been independently analyzed. The procedure was subsequently used to determine the mercury concentration of two new Standard Reference Materials being offered by the National Bureau of Standards. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 33393, 33494, and 34322.

33060 (ANL-7893) INVESTIGATION OF POSSIBLE LINE-LENGTH EFFECTS IN THE MEASUREMENT OF OXYGEN AND HYDROGEN IMPURITIES IN SODIUM. Ruther, W. E.; Skladzien, S. B. (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 20p. Dep. NTIS.

The response of on-line impurity meters to step changes in oxygen and hydrogen activities of flowing sodium were measured before and after the sodium had passed through 100 ft of Type 304 stainless steel tubing. Tests were conducted at sodium temperatures of 350, 450, and 565°C with electrochemical oxygen meters and at 450 and 565°C with diffusion-type hydrogen meters at sodium flow rates of 2.5 and 5 gpm. Both increasing and decreasing step changes in the activities of oxygen and hydrogen were introduced in separate experiments. The levels of these impurities were chosen to simulate those expected in an LMFBR. No adsorption-desorption effects on the walls of the 100 ft of tubing could be detected by the on-line meters. The uncertainty on the meter readings was ~4% for the oxygen meters and ~6% for the hydrogen meter. Thus, no loss of sampling accuracy would be encountered by locating the sampling or monitoring station 100 ft from the main sodium system of a liquid-metal-cooled fast breeder reactor. (auth)

33061 (BMBW-FBK-71-17, pp 29.1-11) POLAROGRAPHIC REDUCTION OF PROTACTINIUM(V) IN AQUEOUS SOLUTIONS AND IN ACETONITRILE. Schwochau, K.; Astheimer, L. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Radiochemie). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Polarographic measurements were performed on purified ^{231}Pa$_2$O$_5$. The electron transitions were calculated according to the Ilkovic equation. The values differed only little from 1; thus the reduction Pa(V)–Pa(IV) appears beyond doubt. The alternating current yield of 80 to 94% indicated a large reversibility of the electrode reaction. Because of the high yield, polarographic determination of protactinium with alternating current appears promising. Preliminary measurements showed that 10^{-5} or 10^{-6} mole Pa(V) concentrations could be determined polarographically. (H.B.G.)

33062 (CNEA-308) IODINE MICRODETERMINATION IN "CARRIER-FREE" AND REDUCER FREE ^{131}I SOLUTIONS. Kurcbart, H.; Quiroga, S.; Caro, R. A.; Radicella, R. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1972. 11p. (In Spanish). Dep. NTIS (U.S. Sales Only).

A photocolorimetric microtechnique by which it is possible to determine the real amount of iodine in "carrier-free" solutions of ^{131}INa is described. The method is conceptually based on the catalytic effect of iodine on the rate of reduction of ceric sulfate by arsenious acid in sulfuric acid solutions, which is proportional to the iodine concentration. The titration, and its corresponding calibration curve, takes approximately 90 minutes. Therefore, it is possible to use this technique as a routine analysis. Under the stated conditions of temperature and time of reaction, it is possible to determine samples with iodine concentrations ranging between 20 and 160 ng/ml. The standard error between different determinations is less than ±5%. The application of the method as a control for the production and the utilization of "carrier-free" ^{131}I solutions, free from a reducing agent, is discussed. (auth)

33063 (LFEN-NI.-66-a) DETERMINATION OF ARSENIC IN URANIUM CONCENTRATES. Barata, Pedro Alves (Junte de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1971. 14p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A simple rapid and precise method for colorimetric determination of arsenic in uranium concentrates is proposed. The sample is dissolved in hydrochloric acid and the arsenic is distilled in the form of arsine. The arsine is absorbed by silver diethyldithiocarbamate. The colored complex form is measured at 545 nm. The interference of uranium, reducing metals, and antimony was determined. A precision of ±0.25 μg was attained. (J.S.R.)

33064 DETERMINATION OF HALOGENIDES IN PHOTOGRAPHIC MATERIALS. Koudelka, Roman. Chem. Prumysl; 22: No. 2, 80-2(Feb 1972). (In Czech).

A method for indirect polarographic determination of bromides and iodides is described. By means of the procedure presented, bromide and iodide ions can be determined in photographic, silver halogenide materials. Provided the overall amount of Ag in the sample is known, it is possible to calculate the amount of iodide, bromide, and chloride ions in 1 gram of the emulsion or in a unit surface area of the film. (auth)

33065 SPECTROPHOTOMETRIC STUDY OF THE COMPLEXATION REACTION BETWEEN YTTRIUM(III) AND ARSENAZO I. Pande, Sunil P.; Munshi, K. N. (Nagpur Univ., India). Curr. Sci. (India); 41: No. 9, 330-1(5 May 1972).

Arsenazo I is recommended as a sensitive reagent for the spectrophotometric determination of yttrium(III) in aqueous solution. The violet colored complex has a $\lambda_{max} = 560$ nm at pH 6.0 ± 0.1. The composition of the chelate is 1 : 1. The stability constant of the chelate was determined by Job's method, mole ratio method, and limiting logarithmic method, at four different fixed values of ionic strength. The value of thermodynamic stability constant of the chelate was determined to be 7.3 ± 0.2. The colored complex conforms to Beer's law over the yttrium concentration of 0.18 to 5.69 ppM. The Sandell sensitivity is 0.0018 ν/cm^2. (auth)

33066 SPECTROPHOTOMETRIC DETERMINATION OF BISMUTH(III) AND THORIUM(IV) WITH METHYL XYLENOL BLUE. Enoki, Takehisa; Mori, Itsuo; Yamazaki, Misako; Inoue, Michiko (Osaka Coll. of Pharmacy, Matsubara, Japan). Jap. Anal.; 21: No. 1, 31-6(Jan 1972). (In Japanese).

Methyl Xylenol Blue (MXB) reacted with bismuth and thorium to form water-soluble complexes. MXB formed a blue complex with thorium in the presence of excess cetylpyridinium chloride (CPC) in an acidic solution, and its color was very stable. These colors were applied for spectrophotometric determinations of bismuth and thorium. The absorbances of the complexes were constant over the pH range from 1.0 to 1.4 (MXB—Bi), and 1.45 to 1.6 (MXB—Th) by adjustment with nitric acid. Linear calibration curves were obtained for 0 to 20 μg/ml of bismuth, and 0 to 23.2 μg/ml of thorium. The recommended analytical procedures of bismuth, thorium, and the separable determination of bismuth and thorium are given. The sensitivities were 0.025 μg/cm^2 of Bi(III), and 0.018 μg/cm^2 of Th(IV) for an absorbance of 0.001. The effects of diverse ions on the absorbance of the complexes were examined. (Japan)

33067 DETERMINATION OF MOLYBDENUM AND COPPER IN BIOSUBSTRATES FROM ONE SAMPLE. Kharkover, S. V.; Kharkover, M. Z. (Ural State Univ., Sverdlovsk, USSR). Gig. Sanit.; No. 1. 71-3(Jan 1972). (In Russian).

A method was developed for determining Mo and Cu in biological substrates by the use of 8-mercaptoquinoline and 8,8′-diquinolyl disulfide. The procedure for dissolving inorganic materials from pretreated organic tissue is given in detail. Extraction with $CHCl_3$ solution of the disulfide and a determination of the optical density of the extract yields a value for the Cu. The Mo is determined in the aqueous phase by means of added oxalic acid, HCl, and thioxine. Mo thioxinate is extracted with $CHCl_3$, and the optical density is measured. (K.S.W.)

33068 SPECTROCHEMICAL ANALYSIS FOR TRACE AMOUNTS OF Ti, B, Zr, AND Be IN 7075 ALUMINUM ALLOY. Muntz, James H. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). Appl. Spectrosc.; 26: No. 2, 312-13(Mar-Apr 1972).

Synthetic standards were prepared and both standards and samples made up to contain 10 mg/ml alloy, 15 mg/ml NaCl, and 0.02 mg/ml In, the internal standard. The accuracy and precision are adequate to establish the metallurgical information required. (M.C.G.)

33069 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM WITH METHYLXYLENOL BLUE. Ueda, Joichi (Kanazawa Univ., Japan). Nippon Kagaku Kaishi; No. 3, 584-7 (Mar 1972). (In Japanese).

A method for spectrophotometric determination of zirconium with Methyl Xylenol Blue (MXB) was studied. Zirconium produces a water-soluble red-brown complex with MXB and its aqueous solution has an absorption maximum at between 572 and 574 nm. The coloration is stable over the pH range from 1.5 to 1.9 and obeys Beer's law up to 1.4 μg/ml of zirconium. The molar absorptivity of the complex and the sensitivity are 4.06×10^4 and 0.0022 μg Zr/cm^2, respectively, according to Sandell's expression. A sample solution containing up to 35 μg of zirconium is transferred to a 25 ml volumetric flask and pH is adjusted to 1.7 by the addition of 2.5 ml of buffer solution of sodium acetate—hydrochloric acid. Then, 1 ml of 0.1% MXB solution is added. After making up the volume to 25 ml and allowing it to stand for 50 min., an absorbance is measured at 573 nm against a reagent blank. The presence of twnety-two diverse ions such as alkali metals, alkaline earth metals, lead, zinc, chromium(III), manganese(II, cobalt, nickel, and rare earth metals does not interfere with the determination. Arsenic(V), antimony(III), bismuth(III), hafnium, thorium, and iron(III), however, interfere seriously. (auth)

33070 POSSIBLE MECHANISM OF LEAD IONIZATION THROUGH ALUMINOSILICATE EMITTER IN ISOTOPIC LEAD ANALYSIS. Shergina, Yu. P.; Shkorbatov, S. S. (All-Union Scientific Research Geological Inst., Sofia). Isotopenpraxis; 8: No. 2, 64-8(Feb 1972). (In Russian).

In isotopic lead analysis the so-called aluminosilicate emitter, a $Al_2O_3-SiO_2-H_3PO_4$ mixture is widely used. The formation of lead ions is influenced by the adsorption of phosphoric acid by the aluminosilicate mixture, which also occurs in clay minerals and natural allophanoids. In neutral or slightly acid agents, phosphate ions are adsorbed in the potential layer of the negatively charged regions of the alumina— silica colloidal mixture. From this results an essential increase of the density of the negative charge of the particle surfaces. In order to compensate the surplus charge, lead ions are removed from the test solution to be transferred to the compensating layer of the colloidal particles. When heating allophanoids, an exothermic reaction is initiated between 950 and 1000°C, which marks the transition of the amorphous mixture into crystalline mullite. Obviously, this exothermic jump causes the emission of weakly bonded lead ions. (auth)

33071 INSTRUMENTAL PROCEDURE TO DETERMINE Fe, Rb, Sr, Y, Zr, Nb, AND Mo IN ROCK POWDERS BY Si(Li) X-RAY SPECTROMETRY. Kunzendorf, H. J. Radioanal. Chem.; 9: No. 2, 311-24(Dec 1971).

The seven elements Fe and Rb through Mo were determined simultaneously in fine-grained rock powder samples by x-ray fluorescence spectrometry. The detection limits for the elements were estimated as 10 to 20 ppM. (D.H.M.)

33072 SPECTROMETRIC DETERMINATION OF IRON IN PLUTONIUM WITH BATHOPHENANTHROLINE. Andersson, L.-H.; Halloff, E. (Foersvarets Forskningsanstalt, Stockholm). FOA (Foersvarets Forsk.) Rep.; 6: No. 4, 1-5(Feb 1972).

A spectrophotometric method for the determination of iron in trace amounts in plutonium was tested. The color-forming reagent used was bathophenanthroline. Iron(III) was reduced to iron(II), complexed with bathophenanthroline and extracted into chloroform. EDTA was used as a masking agent for plutonium. In the presence of different anions (chloride, nitrate, sulfate, perchlorate, and acetate) in the water phase the molar absorptivity of the complex was found to vary. The effect of chloride and nitrate ions was investigated and could be eliminated. Trouble in the extraction step caused by the presence of gallium could be overcome. When iron is estimated in 20-mg samples of plutonium the relative standard deviation obtained is slightly better than 1.2% of the iron concentration when the iron-to-plutonium mole ratio is around 2×10^{-3}. The limit of detection is of the order of 0.1 μg of iron. (Sweden)

33073 EXTRACTION-PHOTOMETRIC DETERMINATION OF URANYL ION USING PHENYLACRYLIC ACID AND RHODAMINE C. Poluektov, N. S.; Bel'tyukova, S. V.; Ognichenko, S. F. (Inst. of General and Inorganic Chemistry, Odessa). Ukr. Khim. Zh.; 38: No. 3, 271-4(Mar 1972). (In Russian).

The conditions for extracting and forming ionic complexes of uranyl ion with phenylacrylic acid, Rhodamine C, or Brilliant Green were studied. The degree of extraction of the metal as a function of the pH of the solution was elucidated. The component ratios in the extracted complex were found to be UO_2^{2+} : Rhodamine : dye = 1 : 3 : 1. The extraction-photometric determination method for determining uranyl ion was applicable over the concentration range 0.05 to 14 μg U/ml. (tr-auth)

33074 FLUORIMETRIC DETERMINATION OF SAMARIUM. Williams, Dora E.; Guyon, John C. (Memphis State Univ., Tenn.). Mikrochim. Acta; No. 2, 194-7(1972).

A fluorimetric method for parts per billion concentrations of samarium in the presence of other rare earth ions was developed. The method utilizes a charge transfer complex between 1,1,1,5,5,5-hexafluoro-2,4-pentanedione and samarium in absolute ethanol.

This complex shows a fluorescence emission maximum characteristic of the samarium, which accounts for the selectivity of the method. (auth)

33075 5,7-DICHLORO-8-HYDROXY-2-METHYLQUINOLINE AND ITS ANALYTICAL POSSIBILITIES. I. Izquierdo, A.; Lacort, G. Inform. Quim. Anal. Pura Apl. Ind.; 24: No. 6, 208-16(1970). (In Spanish).

The reactivity of the reagent with ≃ 50 inorganic ions at various pH values is examined. In general it shows the same lack of selectivity as 8-hydroxyquinoline. In acid solutions precipitates are obtained only with Hg(II), WO_4^{2-}, Cu(II), Sn(II), MoO_4^{2-}, Au(III), V(V), and Ce(IV), in some instances with high sensitivity. The precipitate may be extracted with an organic solvent, e.g., butanol, ethyl ether, $CHCl_3$, or benzene, to concentrate the complex. Fluorescent complexes are obtained with some metal ions and the fluorescence of their organic solutions was examined at 360 nm. The ether solution of the Be complex can be used for detecting down to 0.04 ppM of Be. (Anal. Abstr.)

33076 AUTOMATIC SPARK GAP CONTROL FOR SPARK SOURCE MASS SPECTROMETRY. Colby, B. N.; Morrison, G. H. (Cornell Univ., Ithaca, N. Y.). Anal. Chem.; 44: No. 7, 1263-6(Jun 1972).

The design, construction, and operation of an inexpensive automatic spark gap controller are described. Some results showing its effectiveness are presented. A feedback loop is formed, which senses the spark breakdown voltage and mechanically adjusts the spark gap width to keep that voltage at some selected constant value. A capacitive divider is used to sense the breakdown voltage and the gap width is adjusted by varying the voltage applied to a solenoid connected to one of the electrode manipulators. (M.C.G.)

33077 VOLTAMMETRY IN METHANOL, ETHANOL, AND SULFOLANE AS SOLVENTS. Coetzee, J. F.; Simon, J. M. (Univ. of Pittsburgh). Anal. Chem.; 44: No. 7, 1129-33(Jun 1972).

The polarographic half-wave potentials of the alkali metal and barium ions were measured in methanol and ethanol as solvents. For methanol, reliable standard potentials are available, and the sets of half-wave and standard potentials are reasonably consistent. Voltammetric data also are reported for a variety of electroactive species in sulfolane as solvent, and some comparisons with corresponding values in acetonitrile are presented. (auth)

33078 ON-LINE COMPUTER-CONTROLLED ELECTRICAL DETECTION IN SPARK SOURCE MASS SPECTROMETRY. Morrison, G. H.; Colby, B. N.; Roth, J. R. (Cornell Univ., Ithaca, N. Y.). Anal. Chem.; 44: No. 7, 1203-6(Jun 1972).

The design and operation of an on-line computer-controlled electrical detection system are described for use in spark-source mass spectrometry. This system involves computer control of the mass spectrometer in either a scanning or peak switching mode with simultaneous acquisition and reduction of data using a PDP-11/20 dedicated computer. The instrumental error of the electrical detection system in the peak switching mode is shown to be 2.3% relative standard deviation. (auth)

33079 PRECISION OF ELECTRICAL DETECTION MEASUREMENTS OF POWDERED SAMPLES IN SPARK SOURCE MASS SPECTROMETRY. Morrison, G. H.; Colby, B. N. (Cornell Univ., Ithaca, N. Y.). Anal. Chem.; 44: No. 7, 1206-10(Jun 1972).

The precision of spark-source mass spectrometry for the analysis of powdered samples was extensively examined using electrical detection. A variety of sample powders were analyzed and indicate that analytical precision on the order of 3 to 6% can be expected. Electrostatic peak switching and computer on-line data acquisition and evaluation helped keep measurement time to a minimum. Several methods of sample pretreatment were used and the resulting electrode homogeneity was evaluated. (auth)

33080 STUDIES OF SPUTTERING IN A GLOW DISCHARGE FOR SPECTROCHEMICAL ANALYSIS. Boumans, P. W. J. M. (Philips Research Labs., Eindhoven, Netherlands). Anal. Chem.; 44: No. 7, 1219-28(Jun 1972).

Sputtering rates of some metals and alloys were measured in a glow discharge with the configuration proposed by Grimm. A linear relationship between the mass sputtered in unit time per unit of current strength and the operating voltage was established for both metals and alloys. Some binary alloys are sputtered at a rate that agrees with the sputtering rates of the components and the composition of the alloy. The results are useful for describing various spectrochemical properties and prospects of the glow discharge, but do not pretend to contribute significantly to the fundamental aspects of sputtering. This is due to secondary effects that occur under the conditions of the experiments. The results allow a tentative evaluation of the possibilities of the glow discharge for thin-layer analysis using emission spectrometry. (auth)

Radiometric and Radiochemical Procedures

Refer also to abstracts 33232, 33394, 33433, and 33463.

33081 (BMBW-FBK-71-17, pp 33.1-7) RAPID METHOD FOR DETERMINATION OF ^{233}Pa IN IRRADIATED ThO_2–UO_2 NUCLEAR FUELS. Neeb, K. H. (Siemens A.G., Erlangen (West Germany)). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The study of ThO_2–UO_2 pellets as fuels for thermal converters requires an analytical procedure by which ^{233}Pa could be determined rapidly and simply. To dissolve the sintered pellets, which are highly resistant nitric acid, a special solution was developed. Through anion exchange, ^{233}Pa was separated from the other radionuclides and was determined by γ-spectrometry. ^{233}Pa yield of the method amounted to 99.7 ± 0.8%. Fission products in the sample were largely removed by the separation process. (H.B.G.)

33082 (CONF-710533) SYMPOSIUM ON AUTOMATIC CONTROL SYSTEMS IN MINERAL PROCESSING PLANTS, BRISBANE, AUSTRALIA, 17–20 MAY 1971. ([Queensland Univ., Brisbane (Australia)]). 366p.

Twenty-one papers are included covering on-stream analysis, mathematical models, and control systems based on present knowledge and hardware. Separate abstracts were prepared for 6 papers. (M.C.G.)

For abstracts of individual papers see: 33035, and 33083–33087.

33083 (CONF-710533–, pp 21-33) ON-STREAM ANALYSIS FOR COPPER, ZINC, TIN, AND LEAD IN PLANT MINERAL SLURRIES USING RADIOISOTOPE X-RAY TECHNIQUES. Fookes, R. A. (Australian Atomic Energy Commission [Research Establishment], Lucas Heights); Gravitis, V. L.; Watt, J. S.; Wenk, G. J.; Wilkinson, L. R.

From Symposium on automatic control systems in mineral processing plants; Brisbane, Australia (17 May 1971).

Radioisotope x-ray techniques are suitable for the rapid on-stream analysis of elements of higher atomic number. Simple sensors can be installed on individual streams and on-stream analysis progressively introduced in the plant leading eventually to complete automation. Successful trails in six Australian mineral processing plants are described. X-ray fluorescence methods were used for copper, zinc, and tin and preferential gamma absorption was used for lead. Laboratory and plant trials show that the four elements can be determined on-stream in most concentrate, feed, and tailing process streams. Precisions of analysis are mostly in the range 1 to 10% of the mean element concentration in the slurry solids. Recent developments in techniques may simplify the problem of representative sampling of large volume process streams and also may enable copper to be precisely determined in many tailing streams. (auth)

33084 (CONF-710533-, pp 49-81) DEVELOPMENTS IN INSTRUMENT DESIGN AND CALIBRATION PROCEDURES FOR X-RAY FLUORESCENCE "ON STREAM" ANALYSIS OF MINERAL PROCESSING STREAMS. Stacey, G. S.; Bolt, W. A. (Mount Isa Mines Ltd. (Australia)).

From Symposium on automatic control systems in mineral processing plants; Brisbane, Australia (17 May 1971).

A prototype on-stream x-ray fluorescence analyser has been in operation in the Mount Isa No. 1 Copper Concentrator to finalize design specifications for on-stream analysis equipment for No. 2 Lead-Zinc Concentrator and the proposed No. 4 Copper Concentrator. The pilot installation was designed to achieve the highest possible analytical accuracy and produce rapid continuous analysis of copper in tailing slurries with widely varying iron and solids contents. Correction for varying iron content is achieved by simultaneous measurement of iron K alpha fluorescent radiation and correction for per cent solids by measuring the transmission of ^{137}Cs gamma radiation through a 15-cm slurry path length. The analyser is currently operating on copper rougher tailing slurries. Chemical checks on the results obtained for this product indicate that the root mean square error is approximately ±0.01% Cu for 100-second determinations. Some preliminary investigations into calibration requirements for analysis of lead, zinc, iron, and silver, in lead–zinc concentrator products resulted in a simplified but accurate calibration procedure which gives a satisfactory empirical correction for matrix effects of the lighter elements. The essential features of multistream slurry analysers for copper and lead–zinc concentrators at Mount Isa are outlined. Reasons are given for preference of high voltage x-ray techniques over radioisotope systems. (auth)

33085 (CONF-710533–, pp 85-93) SYSTEM DESIGN FOR ON-STREAM ANALYSIS AT NEW BROKEN HILL CONSOLIDATED LIMITED. Hinckfuss, D. A.; Stump, N. W. (Zinc Corp. Ltd., Broken Hill (Australia)).

From Symposium on automatic control systems in mineral processing plants; Brisbane, Australia (17 May 1971).

The on-stream analysis of lead in ore slurries involving two gamma absorption measurements is well established. A continuous sample of slurry is extracted from the main stream and passed through robust flow cells where the absorption measurements are made. However, sample presentation for the on-stream analysis of zinc using the same sampling procedure with flow cells has presented a stumbling block. The low-energy radiation involved necessitates the use of thin Mylar windows which, in the flow cell configuration, quickly abrade and become holed. The problem was overcome by using a probe assembly dipping into the main stream of slurry. With the establishment of the basic components for lead and zinc analysis, an overall system of on-stream analysis incorporating a digital computer was designed. The basis of the design is explained. (auth)

33086 (CONF-710533–, pp 97-109) APPLICATIONS OF COMPUTER CONTROLLED X-RAY SPECTROMETERS IN PROCESS CONTROL. Browne, I. B. (Philips Industries Ltd., Sydney (Australia). X-ray Applications Lab.).

From Symposium on automatic control systems in mineral processing plants; Brisbane, Australia (17 May 1971).

Computer uses in x-ray fluorescence spectroscopy offer automatic data conversion, a high degree of spectrometer control, built-in check procedures, and a greater overall versatility than was offered by logic-circuitry controlled systems. The operation of a computer-controlled spectrometer is discussed with reference to the analysis of cement slurry. (M.C.G.)

33087 (CONF-710533–, pp 113-27) NUCLEAR TECHNIQUES FOR ON-STREAM ANALYSIS OF URANIUM SOLUTIONS AND SLURRIES. Snyman, G. C. (Atomic Energy Board, Pretoria (South Africa)).

From Symposium on automatic control systems in mineral processing plants; Brisbane, Australia (17 May 1971).

The uranium mining industry in South Africa produces three types of uranium samples: granular ore samples with low uranium concentration, liquid or slurry streams with low uranium concentrations, and liquid or slurry streams of high concentration (final products). Nuclear techniques were developed for analysis of these samples. The natural radiation from uranothorianite minerals was used to control the cut points of a James table sorting heavy minerals. A gamma absorption gauge was developed to analyze the final product stream (ammonium diuranate containing 15 to 40% U_3O_8). The results of the on-line analyzer had an average relative error of 0.45% when compared with chemical analyses over several weeks. Prospecting and ore samples usually consist of dry granular samples with an U_3O_8 concentration of 0 to 1000 ppM. A radioisotope x-ray fluorescence analyzer was developed, which uses a Ge(Li) detector and 100-mCi ^{57}Co source. It has a lower limit of detection of 11 ppM uranium and can handle 250 samples per day. This analyzer, fitted with a flow cell, was also used to analyze liquid streams with a uranium concentration in the same range. (auth)

33088 (INR–1337) METHODS FOR THE DETERMINATION OF NATURAL URANIUM AND ^{235}U IN URINE USED FOR MONITORING THE URANIUM-EXPOSED WORKERS IN THE INSTITUTE OF NUCLEAR RESEARCH. Piskorska-Chlebowska, Anna; Geisler, Jan (Institute of Nuclear Research, Warsaw (Poland)). 1971. 24p. (In Polish). Dep. NTIS (U. S. Sales Only).

Methods for determination of uranium in urine, for monitoring uranium-exposed workers, are described in detail. There are two procedures for natural uranium, a quick and simple method based on direct fluorimetric determination of uranium in the ashed urine sample and a time-consuming, but more accurate, method in which separation of uranium by extraction using ethyl acetate precedes measurement of the fluorescence. A method for estimation of uranium-235 also consists of extraction with ethyl acetate but then the separated uranium-235 is determined by measuring the alpha activity of the sample. (auth)

33089 (KFK-EXT–4/71-32) DETERMINATION OF FISSILE MATERIALS BY MEANS OF DELAYED NEUTRON MEASUREMENTS. Baumung, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1970. 53p. (In German). INIS.

The possibility of determining the amount of fissile material in 200-l scrap barrels of a fuel element fabrication plant by counting delayed neutrons was investigated. The fissions were induced by 14-MeV neutrons and slowed-down 14-MeV neutrons produced by a pulsed neutron generator. The delayed neutrons were detected by a high-sensitivity configuration of $^{10}BF_3$ counters. The radial, azimuthal, and axial spatial dependence of the sensitivity was measured in barrel mock-ups. These contained strongly moderating (hydrogenous) material of various densities or weakly moderating scrap (iron). The radial and azimuthal dependence turned out to be equivalent. By performing two measurements, the second with the barrel turned by 180°, and taking the average, the strong radial (azimuthal) variation of the sensitivity was reduced from a factor of 6 to about 20%. Axial dependence is strong but rather insensitive to the contents of the barrel. By measuring the barrel in layers it can be reduced to less than 10%. The variation of the detection probability with density of moderating contents found by experiment could be confirmed by Monte Carlo calculations and explained by a simple theoretical model. By means of the "add-a-gram" technique this dependence is reduced from a factor of 7 to 10%. The discrimination between ^{235}U and ^{238}U is studied and problems arising with Pu-containing scrap are discussed. (INIS)

33090 (KFK-EXT–4/71-33) SOME APPLICATION POSSIBILITIES OF HIGH-RESOLUTION GAMMA SPECTROSCOPY FOR THE DETERMINATION OF FISSILE MATERIALS. Wolff, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Mar 1971. 41p. (In German). INIS.

The possibility of measuring nondestructively the fissile material content in fuel pins with high resolution gamma spectrometry (Ge(Li)) was investigated. The first part deals with application of natural gamma activity. In the absence of plutonium the determination of the ^{235}U content in homogeneous reactor pins is possible in less than 6 minutes with an accuracy of 1% with the aid of the characteristic 185-keV γ line of ^{235}U. Plutonium causes an increase of Compton background and therefore the need of longer measuring-time. Plutonium is determined using the 414-keV photons emitted by ^{239}Pu. The intensity of the radiation is strong enough to achieve a precision and reproducibility of 0.5% in 10 minutes. The application of the passive gamma assay depends primarily on the quality of fuel homogeneity. In order to check the spatial distribution of the fissile material it is sufficient to compare the ratio of the 185-keV intensity (414 keV) to the 98.4-keV UK(α1) radiation relative to that of the standard. This ratio was extremely dependent on the degree of inhomogeneity. In the second part it is demonstrated that neutron-induced fission product γ spectra of ^{239}Pu and ^{235}U after short term irradiation show characteristic differences. This can also be used for fissile material assays in fuel pins. (INIS)

33091 (NP–19247) SOME DETECTION METHODS IN RADIOCHROMATOGRAPHY AND THE MEASUREMENT OF TRITIUM AND OTHER LOW ENERGY β-EMITTERS. Prydz, Svein (Oslo Univ. (Norway). Fysisk Institutt). 1971. 112p.

Ten papers were compiled on new methods of tracer detection in radiochromatography. A short description is given of some of the equipment used in several of the studies. The papers are summarized and discussed. Separate abstracts were prepared for 3 papers. The remaining seven papers were previously abstracted for NSA. Abstract numbers for these papers are: 22: 38024; 24: 11454, 11456. 11457, 18903, 38752; and 25: 48924. (M.C.G.)

For abstracts of individual papers see: 33097, 33098, and 33398.

33092 (PNC-N–831-70-2, pp 79-83) DETERMINATION OF ^{106}Ru IN SEA BED SAND. Yamato, Aiji; Watanabe, Shosuke; Miyahara, Kenji (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345–12).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Description is made of two distillation methods after HNO_3 leaching for the determination of ^{106}Ru. The ^{106}Ru was leached with hot HNO_3 from sand, and then distilled into NaOH solution, from which the ruthenium was precipitated by methyl alcohol. Beta activity of the precipitate was measured with a low background 2-π gas-flow counter, and the chemical yield was determined by colorimetry at 400 mμ. Overall recovery of 97% was obtained. Thus, in the standard method, samples are treated with concentrated HNO_3 in a distillation flask, and distilled immediately without separation of residue with a rotary evaporator to avoid sputtering. The distillation is carried out with the addition of 50 ml (1 + 1) H_2SO_4 and 2 to 5 g $KMnO_4$, at 110°C for 30 minutes. The distillate is trapped in 630 ml of 6N NaOH. Colorimetry is carried out with 5 ml of the distillate for examination of the chemical yield. To 45 ml, 3 ml alcohol is added. and counting is done on the precipitate. In the rapid method, samples are boiled with concentrated HNO_3 for 5 minutes. On addition of (1 + 1) H_2SO_4 and 5 to 10 g $KMnO_4$, the solution is treated in a rotary distillator for 30 minutes at 150 rpm. The distillate is collected in 6N NaOH, and treated as in the standard method. (Japan)

33093 SIMULTANEOUS ASSAY OF ^{45}Ca AND ^{89}Sr IN DOUBLE-ISOTOPE BIOLOGICAL SAMPLES BY LIQUID SCINTILLATION COUNTING. Hardcastle, J. E.; Fuller, W. H.; Hannapel, R. J. (Univ. of Arizona, Tucson). Contract AT(11-1)-947. Anal. Biochem.; 46: No. 2, 534-47(Apr 1972).

A method for simultaneously counting ^{45}Ca and ^{89}Sr in samples from radioactive tracer experiments is described that consists of dissolving the calcium and strontium salts in toluene and di-n-propyl phosphate. Some aspects of the method considered are fluor systems; optimum DNP/toluene ratio and sample volume; salt-holding capacity of the DNP/toluene matrix; precision and efficiency; linearity of counting; cation interferences; anion interferences; reagent and sample stability; and application of the double isotope method to biological samples. (D.H.M.)

33094 IMPROVED METHOD FOR COLLECTION AND MEASUREMENT OF RADIOACTIVITY IN COMPOUNDS SEPARATED BY GAS—LIQUID CHROMATOGRAPHY. Watson, G. R.; Williams, J. P. (Univ. of Toronto). J. Chromatogr.; 67: No. 2, 221-6 (3 May 1972).

^{14}C-Labeled compounds in the effluent of a gas—liquid chromatograph were collected intact by condensation and adsorption to small glass beads coated with silicone fluid in short glass cartridges and then eluted into scintillation vials for counting. The overall recovery of radioactive fatty acid methyl esters and trimethylsilyl derivatives of glycerol and glucose was greater than 90%. (auth)

33095 DETERMINATION OF RADIUM-D IN THE AIR. Efimova, A. N.; Vorob'ev, A. M.; Kiselev, V. I. Gig. Sanit.; No. 1, 69-71(Jan 1972). (In Russian).

A method for the determination of Ra—D ^{210}Pb was developed, and consists of first removing the Pb and Bi by sorption on an anion exchange resin. Ra, Ac, U, Th, Pa, and many nonradioactive substances are not caught by the resin but appear in the filtrate. At least 5 m^3 of air are drawn through a filter to provide a working sample. The filter is burned at 500°C in a muffle furnace, the residue is moistened with HCl, evaporated, then taken up in HCl. The solution is passed through a resin column, and the RaD and RaE are subsequently desorbed with HNO_3, and counted with an end counter. The sensitivity of the method is at least 10^{-13} Ci/l. (K.S.W.)

33096 DETERMINATION OF ^{239}Pu IN BONE. Novoselova, G. P.; Voronina, T. F.; Golutvina, M. M. (Inst. of Biophysics, Moscow). Gig. Sanit.; No. 1, 73-5(Jan 1972). (In Russian).

The optimum conditions of concentration, separation, and measurement of ^{239}Pu, after the latter had been added to ashed bone tissue, were established. Bone tissue was ignited in a muffle furnace at 600°C, and the inorganic residue was dissolved in HNO_3. The Pu was extracted with TBP, re-extracted with aqueous hydroxylamine HCl, and precipitated from solution onto bismuth phosphate. The latter was washed, mixed with a phosphor, and the Pu was determined in a scintillation counter. (K.S.W.)

33097 TRITIUM DETECTION BY β-RADIOLUMINESCENCE IN STANDARD MEDIA FOR THIN-LAYER CHROMATOGRAPHY. Prydz, Svein; Skammelsrud, Kare S. (Univ. of Oslo). J. Chromatogr.; 32: 732-6(1968).

See NP—19247.

The relative β scintillation efficiencies of several thin-layer media for chromatography were determined at room and lower temperatures. In addition, the spectral composition of the emitted luminescence (for the most efficient media) was investigated to obtain a basis for choosing photomultiplier or film material with appropriate spectral response for optical detection. A broad-band emission (500 to 700 nm) was found, where a dominant peak at about 650 nm was due to gypsum admixture (as a binder). The sensitivity for tritium detection by luminescence was estimated. (auth)

33098 SPECTRAL COMPARISON BETWEEN SOME SOLID SCINTILLATORS USED IN THIN-LAYER RADIOCHROMATOGRAPHY FOR β-RADIOLUMINESCENCE DETECTION OF TRITIUM. Prydz, Svein; Seim, Thorstein; Koren, Jan F. (Univ. of Oslo). Phys. Norv.; 4: Nos. 3-4, 247-50(1970).

See NP—19247.

The emission spectra of β-excited luminescence were obtained for three scintillators: anthracene, sensitized zinc silicate, and frozen benzene, which were all earlier suggested as suitable for label activity determination in radiochromatography. The spectra were fully corrected for the wavelength-dependent sensitivity of the measuring system. The relative usefulness of the three scintillators in combination with a particularly sensitive photodetector are given as scintillation detectabilities. Photon yields and energetic efficiencies are stated. From these quotations the usefulness of the scintillators in combination with other known detectors can be also judged. (auth)

33099 COPRECIPITATION AS A MEANS OF SEPARATION IN SUBSTOICHIOMETRIC ISOTOPE DILUTION ANALYSIS. I. GENERAL CONSIDERATIONS AND INTRODUCTION. Polak, H. L. (Univ. of Amsterdam). J. Radioanal. Chem.; 9: No. 2, 241-9(Dec 1971).

Coprecipitation is proposed as a means of obtaining the necessary separation in substoichiometric isotope dilution analysis. It is shown with examples that by applying coprecipitation for separation and by using complexometric and oxidimetric or reductometric reactions as the substoichiometric reaction, a wide field of complexometric determinations of metal ions (e.g., with EDTA) and many types of redox determinations open up for further investigations. The method is simple, not time-consuming and offers many possibilities owing to the freedom to select a suitable precipitate. (auth)

33100 DESIGN AND PERFORMANCE OF TRITIUM MEASUREMENT SYSTEMS USING ELECTROLYTIC ENRICHMENT. Hartley, P. E. (Australian Atomic Energy Commission Research Establishment, Sutherland). Nucl. Instrum. Methods; 100: No. 2, 229-35(1972).

Equations and data are given which enable the enrichment, reproducibility, electrical characteristics, and heat output of electrolytic tritium enrichment cells to be calculated. From these equations, together with the characteristics of the counting method, the overall performance of a tritium-counting system may be estimated. Two theoretical system designs using liquid scintillation emulsion counting are given. One uses an initial sample volume of 3 l and measures 1 T.U. to ±10% with a throughput of 40 samples per week. The other uses a sample volume of 0.5 l and measures 5 T.U. to ±10% at the same throughput. (auth)

33101 INVESTIGATION AND RADIOMETRIC DETERMINATION OF SATURATED AND UNSATURATED ALIPHATIC DICARBOXYLIC ACIDS. Oemboely, Cs.; Szarvas, T.; Vegh, G. (Isotope Inst., Budapest). J. Radioanal. Chem.; 9: No. 2, 229-39(Dec 1971).

Radiometric determination of saturated and unsaturated aliphatic dicarboxylic acids was developed using a precipitation reaction. The influence of the conditions of precipitation, the composition of the calcium salts of the acids, the pH, and the composition of solvent mixtures were investigated. The solubility of the calcium salts diminished with an increase of the ethanol content in weakly alkaline medium. Linear relations were found between the solubilities of the calcium salts and the dielectric constants of the solvent mixtures. The calcium salts have poor solubilities at pH 9 in 20% aqueous ethanol containing ammonia. The radiometric titrations were carried out in 0.05M solutions, using 0.05M ^{45}Ca-labeled $CaCl_2$ solution in 20% aqueous ethanol. The titrations were done in an apparatus suitable for the detection of soft β-emitting isotopes. (auth)

33102 DETERMINATION OF THE Si AND Ge CONTENT IN SiGe ALLOY BY GAMMA RAY ABSORPTION SPECTROSCOPY. Nelson, G. C. (Sandia Labs., Albuquerque, N. Mex.). J. Radioanal. Chem.; 10: No. 2, 267-72(Apr 1972).

Gamma absorption spectroscopy was used to accurately determine the Si and Ge content in Si—Ge alloys. This technique provides a fast, accurate, and nondestructive method for determining concentrations of components in binary systems. (auth)

33103 DETERMINATION OF SMALL QUANTITIES OF ^{51}Cr (III) IN THE PRESENCE OF LARGE QUANTITIES OF ^{51}Cr(VI) BY COPRECIPITATION WITH ZINC HYDROXIDE. Collins, K. E.; Collins, C. H.; Yang, M. H.; (and others) (National Tsing Hua Univ., Hsinchu, Taiwan). J. Radioanal. Chem.; 10: No. 2, 197-201(Apr 1972).

A procedure is described for the determination of ^{51}Cr(III) in ^{51}Cr(VI) samples having a ^{51}Cr(VI) to ^{51}Cr(III) ratio of 10^5, by means of a single zinc hydroxide coprecipitation at a pH of ca. 13. Acceptable precision (standard deviation of 10 to 15%) is possible with solid ^{51}Cr(VI) samples containing 10 ppM of ^{51}Cr as ^{51}Cr(III). (auth)

33104 ISOTOPE GAS ANALYSIS OF TRITIUM-LABELLED WATER BY MEANS OF AN AUTOMATIC APPARATUS. Gacs, I.; Mlinko, S.; Payer, K. (Central Research Inst., Budapest). J. Radioanal. Chem.; 10: No. 2, 203-12(Apr 1972).

A procedure and an automatic apparatus designed for the radioactivity measurement of tritium-labeled water in the gaseous phase are described. The method is based on the conversion of water to hydrogen, methane, and carbon monoxide in a carbon-packed quartz reactor. The reaction products are swept by hydrogen carrier gas into a piston-type counter tube. Methane is fed to the radioactive gaseous mixture, and the radioactivity of the hydrogen—methane—carbon monoxide mixture is measured in the limited proportional region. The radioactivity values are correlated with the weight of the sample taken and the results are corrected for the "memory effect" obtained in the measurement of inactive water samples. The standard deviation of the procedure, characteristic of its reproducibility, is lower than ±0.5% rel. at a preset number of counts. (auth)

33105 EXTRACTION–SCINTILLATION METHOD FOR DETERMINING THE CONCENTRATION OF RADIOISOTOPES. Gorbushina, L. B.; Zhiltsova, L. Ya.; Matveeva, E. N.; (and others). (Joint Inst. for Nuclear Research, Dubna, USSR). J. Radioanal. Chem.; 10: No. 2, 165-72(Apr 1972).

A method is presented for the determination of uranium isotopes in water by the scintillation—extraction method. By extraction with tributyl phosphate (TBP) in toluene as a liquid scintillator it was established that the presence of TBP in the solvent does not affect the photo yield substantially. The optimum measuring conditions and the sensitivity of the method were studied. (auth)

33106 PREPARATION OF GAS SAMPLES FOR LIQUID SCINTILLATION COUNTING OF ^{14}C. Bosshart, R. E.; Young, R. K. (Bituminous Coal Research, Inc., Monroeville, Pa.). Anal. Chem.; 44: No. 7, 1117-21(Jun 1972).

A scintillation procedure for determining carbon-14 in gases is described. Samples are collected in evacuated cylinders and passed through a catalytic oxidation unit. The carbon dioxide formed is trapped in a pre-weighed amount of ethanolamine contained in a counting vial. Methanol and scintillator solutions are then added to form the scintillator cocktail. The radioactive concentration of the gas is determined by multiplying the ratio of the known volume of carbon dioxide trapped to the mole fraction of the carbon components, determined by gas chromatography, by the disintegrations per minute counted in the ethanolamine—carbonate. The counting efficiency is a constant value of 72.0%. The method is precise and requires a minimum of operator attention. The calculated detection limit is 0.04 dpm/ml (STP). (auth)

Separation Procedures

Refer also to abstracts 33185, 33205—33207, 33230, 33233, 33234, 33237, 33547, and 34956.

33107 (BMBW-FBK–71-17, pp 34.1-12) SEPARATION OF PROTACTINIUM FROM ANALOGOUS AND OTHER ELEMENTS. Palschin, E. S.; Dawydow, A. W.; Palei, P. N.; Iwanowa, L. I.; Wernadsky, V. I. (Akademiya Nauk SSSR, Moscow. Institut Geokhimii i Analitecheskoi Khimii). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Conditions for separation of protactinium from associated elements in complexing media ($H_2C_2O_4$, HF) were studied with precipitation and extraction procedures. Precipitation of protactinium peroxide from $H_2C_2O_4$ solutions by means of continuous introduction of H_2O_2 and HCl permits high yield separation of protactinium from large amounts or traces of niobium, zirconium, tantalum, and others. Extraction from HF solutions with trioctylamine in xylene with subsequent washing of the extracts with suitable complexing agents led to separation of protactinium from silicon, niobium, tantalum, and others. For separation of protactinium from zirconium and other elements, extraction from 7 M HCl—0.3 M $H_2C_2O_4$ with tetraphenylphosphonium chloride was used. (tr-auth)

33108 (BMBW-FBK–71-17, pp 35.1-10) PROTACTINIUM SEPARATION FROM ACCOMPANYING ELEMENTS BY EXTRACTION USING 1-PHENYL-3-METHYL-4-BENZOYLPYRAZOLONE-5. Mjasojedow, B. F.; Palei, P. N.; Molotschnikowa, N. P. (Akademiya Nauk SSSR, Moscow. Institut Geokhimi i Analitecheskoi Khimii). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The extraction of protactinium, niobium, and tantalum through a 0.1 M solution of 1-phenyl-3-methyl-4-benzoylpyrazolone-5 in benzene from hydrochloric, nitric, and sulfuric acid solutions was studied. Quantitative extraction of protactinium was performed after 2 min of shaking from 0.1 to 5N solutions of the acids. Homogeneous distribution of niobium, and especially of tantalum, occurred slowly; the slowness increased with decreasing acid concentrations. Greatest differences in the extraction of protactinium, niobium, and tantalum were found in sulfuric acid solutions. (H.B.G.)

33109 (BMBW-FBK–71-17, pp 36-1-14) EXTRACTION OF PROTACTINIUM AS ASSOCIATED ION. Palschin, E. S.; Dawydow, A. W.; Paley, P. N.; Iwanowa, L. A.; Wernadsky, W. I. (Akademiya Nauk SSSR, Moscow. Institut Geokhimi i Analitechneskoi Khimii). Oct 1971. (In German).

From third international protactinium conference, Schloss Elmau, Germany (15 Apr 1969).

The extraction of protactinium and its analog elements as complexes of oxalate, tartrate, and halogenides was studied. Tributylamine, trioctylamine, and tetraphenylphosphonium chloride were used as reactants. Charges of the extracted anion complexes of protactinium were determined. Protactinium extraction was correlated with stability, amount, and charge of the complexes. (tr-auth)

33110 (BMBW-FBK–71-17, pp 37.1-11) ADSORPTION OF PROTACTINIUM(V) FROM SULFURIC ACID SOLUTIONS ON VYCOR GLASS 7930. Kaiser, G.; Merz, E. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Oct 1971. (In German).

From 3. international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Experimental studies showed that trace amounts of protactinium could be separated from sulfuric acid solutions of low acidity by adsorption on Vycor glass. Approximately 1% of the protactinium remained in solution. Applicability of the procedure for reprocessing of nuclear fuels must be held in abeyance until results with larger amounts of protactinium become available. (tr-auth)

33111 (BMBW-FBK–71-17, pp 38.1-9) SELECTIVE PROTACTINIUM SORPTION BY CHELATING RESINS-AZO DERIVATIVES OF AMINOPOLYSTYROL. Mjysojedow, B. F.; Jelisejewa, O. P.; Sawwin, S. B. (Akademiya Nauk SSSR, Moscow. Institut Geokhimii i Analitecheskoi Khimii). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Protactinium sorption by chelating resins based on aminopolystyrene which contained arseno- and other salt-forming groups was studied. The chelating resins were synthesized through a coupling reaction between diazoaminopolystyrene with o-hydroxyphenylarsonic acid, 3-[(o-arsonphenyl)azo]-4,5-dihydroxy-2,7-naphthalenedisulfonic acid, (Arsenazo I), and with several other monoazo derivatives of chromotropic acid. Under static conditions, sorption of Pa, Zr, Nb, U, Th, and Po from hydrochloric and sulfuric acid solutions was studied with respect to its dependency on acid concentration. Feasibility was demonstrated for separation of Pa from Fe, Zr, Nb, U, Th, and Po in 10 N H_2SO_4 solution by sorption on a resin that was produced through a coupling reaction between diazoaminopolystyrene and Arsenazo I. (H.B.G.)

33112 SEPARATION IN EXTRACTION SYSTEMS CONTAINING DIANTIPYRYLMETHANE. III. PHASE EQUILIBRIA IN THE SYSTEM: CHLOROFORM–BENZENE–DIANTIPYRYLMETHANE DINITRATE AND HEXANITROZIRCONATE. Yakovleva, T. P.; Zhivopistsev, V. P.; Petrov, B. I.; Mochalov, K. I. (Perm State Univ., USSR). Zh. Obshch. Khim.; 41: No. 10, 2121-6(Oct 1971). (In Russian).

Extraction of Zr from a medium containing HNO_3 is possible through the formation of the complex $(DH)_2[Zr(NO_3)_6]$, where D represents diantipyrylmethane. The quaternary system $CHCl_3$—C_6H_6—diantipyrylmethane dinitrate—diantipyrylmethane hexanitrozirconate was studied in three sections at $CHCl_3$ = 25, 50, and 75% by weight. The region of two-phase equilibrium that offers greatest interest for a Zr extraction method occupies almost half the volume of the concentration prism. The best solvent composition for low Zr concentrations was benzene—50 to 40% $CHCl_3$. (K.S.W.)

33113 SEPARATION OF IODOAMINO ACIDS AND IODIDE BY PAPER CHROMATOGRAPHY WITH AQUEOUS SOLVENTS. Jaiswal, D. K.; Chander, Jagdish; Singh, B.; Chakraborty, K. P. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). J. Chromatogr.; 67: No. 2, 373-5(3 May 1972).

A method is described that uses 3% sodium chloride solution as solvent system for the separation of iodoamino acids and iodide by one-dimensional ascending paper chromatography and takes only 1½ hrs. (D.H.M.)

33114 CATION EXCHANGE PROPERTIES OF TANTALUM PHOSPHATE. Nomura, Minoru (Dainippon Ink and Chemicals Inc., Tokyo); Abe, Mitsuo; Ito, Takuji. Nippon Kagaku Kaishi; No. 3, 529-33(Mar 1972). (In Japanese).

Tantalum phosphate was prepared by adding a concentrated hydrochloric acid solution of tantalum pentachloride to an aqueous solution of phosphoric acid. After the gelatinous precipitate was allowed to stand for 25 hr in contact with the solution, it was separated, washed, and dried. The tantalum phosphate, $TaO_2(H_2PO_4)_{0.88} \cdot 6\ H_2O$, is amorphous and chemically stable. From acid-base titration curves, it was found that tantalum phosphate is a typical weak acid cation exchanger having the capacity up to 3.8 meq/g in an alkaline solution. Affinities of tantalum phosphate to alkali metal ions increased in order $Li^+ < Na^+ \ll K^+ < Rb^+ < Cs^+$ similar to that in organic cation exchangers or zirconium phosphate. The value of separation factor between Na^+ and K^+ was greater than that of strongly acid organic cation exchanger under the same condition. A tentative explanation for the cation exchange mechanism of tantalum phosphate was based on acid-base titration curves and infrared spectra: hydrogen ion produced by the dissociation of dibasic phosphoric acid group is exchanged by alkali metal ions in a relatively low pH solution. (auth)

33115 SEPARATION OF CALCIUM, STRONTIUM, AND BARIUM ON COLUMNS OF COMPLEXING RESINS OF THE STYRENE PHOSPHONATE TYPE. Sanchez Batanero, P.; May, S.; Burriel-Marti, F. (Univ., Madrid). Inform Quim. Anal. Pura Apl. Ind.; 24: No. 6, 190-9(1970). (In Spanish).

The sorption of Ca(II), Sr(II) and Ba(II) from a medium of mM-1,2-diaminocyclohexane-N,N,N′,N′-tetraacetic acid and 10 mM-NH_4NO_3 at different pH values on a styrene phosphonate resin (Bio-Rex 63, NH_4^+ form) was examined and found to increase in the order Ca(II), Ba(II), Sr(II). If elution is effected at pH 7 with a solvent of concentration 10 times the above, the order of elution is Ca(II), Sr(II), Ba(II). The partition coefficients were measured by a radioactive-tracer technique. (Anal. Abstr.)

33116 SYNTHESIS OF TIN (IV) ANTIMONATE OF HIGH THERMAL AND CHEMICAL STABILITY. SEPARATION OF Mg^{2+} FROM Sr^{2+}, Cd^{2+}, Cu^{2+}, Al^{3+}, AND La^{3+}. Qureshi, Mohsin; Kumar, Virendra; Zehra, Nighat (Aligarh Muslim Univ., India). J. Chromatogr.; 67: No. 2, 351-61(3 May 1972).

Seven samples of antimonates of tin(IV), iron(III), and thorium(IV) were synthesized under various conditions. The chemical stabilities of these antimonates were determined in dilute solutions of mineral acids. The distribution coefficients of metal ions were determined at different pH values on tin(IV) antimonate. The analytical importance of this exchanger was demonstrated by achieving the separations of some important pairs of metal ions. (auth)

33117 BISMUTH TELLURATE: AN INORGANIC ION EXCHANGER. Rahman, M. K.; Haq, A. M. S.; Maroof, F. B. A. (Atomic Energy Centre, Dacca, Pakistan). J. Chromatogr.; 67: No. 2, 389-92(3 May 1972).

Since inorganic ion exchangers are very stable under high temperature and high doses of radiation, they can be used in the recovery of highly radioactive fission products. The composition and some ion exchange properties of bismuth tellurate are reported and further study is underway on the distribution of different ions, especially those which constitute fission products. (D.H.M.)

33118 EXTRACTION OF SOME INORGANIC IONS BY N,N-DIBUTYL DIETHYL CARBAMYL PHOSPHONATE FROM NITRIC ACID MEDIUM. Aly, H. F.; Kandil, A. H. T.; Raieh, M. (Atomic Energy Establishment, Cairo). Z. Anal. Chem.; 258: No. 4, 281-2 (1972).

The extractions of Hf, In, Tm, Eu, Ce, Ag, Mo, Sr, Co, Cs, and Se were studied. Distribution ratios are compiled and compared with values obtained using TBP. For all the elements the dibutyl diethylcarbamoylphosphonate (DBDECP) had a higher extraction ability than TBP. (M.C.G.)

33119 MOLYBDENUM SORPTION FROM SULFURIC ACID SOLUTION IN THE PRESENCE OF FORMIC AND ACETIC ACIDS. Sagortschew, B. N.; Todorova, N. G.; Balusev, B. St. (Inst. for Chemical Tech., Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 8, 1063-6(1971). (In German).

The sorption of Mo on a cation exchange resin (Kationit KY-2) from a water medium depends on the H^+ ion, which in turn determines the ion form of the Mo. Data were obtained for the dependence of Mo sorption on Kationit KY-2 on the concentration of 0.1N H_2SO_4, acetic acid, and formic acid. A minimum sorption of Mo occurred at about 50% HCOOH in the presence of 0.0001N H_2SO_4. Data were also obtained on the sorption of Mo on an anion exchange resin Wofatit L-65. (K.S.W.)

33120 THIN-LAYER CHROMATOGRAPHY OF INORGANIC CATIONS ON CRYSTALLINE CERIUM(IV) PHOSPHATE SULFATE. Koenig, K.-H.; Graf, H. (Univ., Frankfurt am Main). J. Chromatogr.; 67: No. 1, 200-2(26 Apr 1972). (In German).

Crystalline cerium(IV) phosphate sulfate was deposited in thin layers on frosted glass plates without binder. The RF values and Debye–Hueckel parameters were determined and tabulated for various cations (Ag, Na, Ca, Hg, Cd, Co, Ni, Cr, Fe, Th) in hydrochloric and perchloric acid solutions. The molecular ratio of $Ce:PO_4:SO_4$ was 1:1.21:0.29. (H.B.G.)

33121 RADIOANALYTICAL PURIFICATION OF PROTACTINIUM BY ANION EXCHANGE IN HYDROFLUORIC ACID–SULFURIC ACID MEDIUM. Bautista, E. R.; Dominguez, G. (Junta de Energia Nuclear, Madrid). An. Quim.; 67: No. 4, 375-82(1971). (In Spanish).

The anion-exchange behavior of Pa and radioactive contaminants in the medium resulting from treatment of neutron-irradiated samples of rocks and ores in the determination of thorium was studied. Distribution coefficients of Pa on Dowex 1-X8 resin show that it is adsorbed quantitatively from 0.2N HF – 0.2N H_2SO_4. Many interfering elements can be washed from the column with 0.1N HF and the Pa is eluted with 10N HF – N H_2SO_4, the only contaminants being Zr, Mo, Sn, and traces of Ru and Te. (TSS)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 33836, 34899, and 34928.

Chemical and Physical-Chemical Properties

Refer also to abstracts 33141, 33190, 33214, 33219, 33220, and 33540.

33122 (NP–19322) OBTAINING HYDROGEN BY MEANS OF REACTOR HEAT. Dorner, Stefan (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct 1971. 66p. (In German). Dep. NTIS (U. S. Sales Only).

Known methods used in the decomposition of water by means of reactor heat are discussed. Theoretical considerations on the development of new methods show that closed-circuit processes with gas components require relatively high temperatures and, therefore, seem to be not very promising. The production of hydrogen by dissolution of the metal and the subsequent conversion into oxide call for a low decomposition temperature of the oxide. Experiments were made with reactions in the molten state in order to convert into oxides the halogenides formed in the closed-circuit process. With a view to complete the closed-circuit processes, exchange reactions and separations through evaporation of some alkaline and alkaline earth halogenides, respectively, and the metals in the Vb-group of the periodic system were checked experimentally. Some considerations were made with respect to economy. (auth)

33123 (WARD–5788) CHEMISTRY OF WATER AND SOLUTIONS AT HIGH TEMPERATURES FOR APPLICATION TO CORROSION IN POWER SYSTEMS. Cohen, Paul (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). [1971]. 129p. (CONF-720323–1). Dep. NTIS.

From Conference cycle on chemistry of water and aqueous corrosion in steam generators; Ermenonville, France (13 Mar 1972).

The structure and unique properties of water are discussed. The thermodynamic relationships of water and solutes are considered. Chemical properties of solutes of interest are presented. In view of the significance of concentrated solutions at heat transfer surfaces, the effects of ionic strength, up to currently permissible levels of prediction, are taken into account. The general considerations are applied to conditions of interest in nuclear and fossil fueled steam-generating systems. (62 references) (M.C.G.)

Isotope Effects

Refer also to abstracts 33808 and 34036.

33124 RELATIVE DIFFERENCE BETWEEN MOBILITIES OF LITHIUM-ISOTOPE IONS AND TRANSFER NUMBERS IN LiF.

Ptashnik, V. B. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2702-8(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3212-19(Nov 1971).

The method of two moving boundaries used for determination of the isotope effect of ionic electromigration in crystals is discussed. Three crystals containing various isotopes were joined in the form of a column in the sequence n_{10}, n_{20}, n_{10} (n_{10} and n_{20} denote the atomic fraction of the light isotopes). The concentration profile at the sample boundary at which the isotope concentration increases in the direction of the field $\mathscr{E}$ has a sharp edge at the end of the experiment, whereas a slanting edge is found at the second boundary. This difference results from the fact that the diffusion and charge-separation currents produced by the electric field are differently directed at the first and second boundary. The relative difference in the mobility of the isotopes can be calculated by comparing the amount of the light isotope passing through boundaries I and II. The result of this comparison is represented by the area $(Q_B - Q_A)$ of the figure which is obtained by mirror superposition of curves I and II. The relative difference in the mobilities of the isotope is $\Delta u/u = [(Q_B - Q_A)\pi F\rho S/2qMt_+]$, where ρ is the density of the crystal, S is the cross-sectional area of the crystal, q is the charge which passed through the crystal, t_+ is the transfer number of cations, M is the molecular weight, and F is the Faraday number. Compared with the classical method of Klemm, the method of two moving boundaries ensures a separation effect which is $8/\pi \simeq 2.5$ times greater than that which is effected in the measurement of small $\Delta u/u$ ratios. The present method was used to measure the relative difference of the mobilities of the lithium isotope ions Li_6^+ and Li_7^+ in LiF single crystals in the temperature interval 600 to 800°C. The quantity $\Delta u/u$ is, within the range of experimental errors, independent of the temperature and amounts to 0.041 ± 0.003. The average value of the isotope effect in electromigration is $E = [\Delta u/u - 1/(m^7/m^6)^{½} - 1] = 0.52 \pm 0.04$. The transfer numbers of lithium ions in LiF single crystals were measured. The transfer number t_+ of the cations changes from 0.90 ± 0.05 at 600°C to 0.73 ± 0.05 at 800°C. (auth)

33125 VAPOR PRESSURES OF ISOTOPIC KRYPTON MIXTURES. INTERMOLECULAR FORCES IN SOLID AND LIQUID KRYPTON. **Lee, Myung W.; Eshelman, Donald M.; Bigeleisen, Jacob (Univ. of Rochester, N. Y.). Contract AT(30-1)-3999. J. Chem. Phys.; 56: No. 9, 4585-92(1 May 1972).**

The vapor pressures of normal krypton and a krypton sample containing 50% ^{80}Kr were measured from 94 to 130°K. New vapor pressure equations are derived for solid and liquid normal krypton. The triple-point pressures and (temperatures) of ^{80}Kr and ^{84}Kr are 547.56_5 (115.77) and 547.50_2 (115.78) int. mm Hg (°K), respectively. The triple-point pressure of normal krypton is 547.52 ± 0.10 int. mm Hg. The reduced partition functions, fc/fg, of $^{84}Kr/^{80}Kr$ were derived for the solid and liquid from the vapor pressure data. The solid data lead to a θ_0 (D) = 71.8°K in excellent agreement with heat capacity data. The change in ln (fc/fg) on melting is found to be 24% in good agreement with previous results on neon and argon. V $\langle\nabla^2U\rangle$ is derived from the experimental values of ln (fc/fg) in the liquid. The repulsive potential in liquid krypton is less steep than that in neon or argon. Calculations of V $\langle\nabla^2U\rangle$ from neutron scattering measurements show the exp-6 potential to be superior to the LJ (12,6) potential for liquid krypton. A corresponding states analysis through $\langle\nabla^2U^*\rangle$ leads to a quantitative correlation of the solid and liquid phase (fc/fg) data for Ne, Ar, and Kr. (auth)

33126 MICROWAVE SPECTRUM OF BF_2OH. **Takeo, H.; Curl, R. F. (Rice Univ., Houston, Tex.). J. Chem. Phys.; 56: No. 9, 4314-17(1 May 1972).**

The microwave spectrum of BF_2OH was observed and assigned. The rotational constants of the isotopic species $^{11}BF_2{}^{16}OH$, $^{10}BF_2{}^{16}OH$, $^{11}BF_2{}^{16}OD$, $^{10}BF_2{}^{16}OD$, $^{11}BF_2{}^{18}OH$, and $^{10}BF_2{}^{18}OH$ were determined. The inertial defects prove that the molecule is planar. Assuming the two BF bond lengths are the same, the bond distances and angles are found to be: $r_{BF} = 1.32$ Å, $r_{BO} = 1.34$ Å, $r_{OH} = 0.94$ Å, <FBF = 118°, <BOH = 114.1°, <FBO = 122.8° (this is the angle cis to the OH). The dipole moment is 1.86 ± 0.02 D. The dipole moment makes an angle of 50° with the BO bond with dipole moment line on the same side of the BO bond as the hydrogen. (auth)

33127 LIQUID–VAPOR ARGON ISOTOPE FRACTIONATION FROM THE TRIPLE POINT TO THE CRITICAL POINT. MEAN LAPLACIAN OF THE INTERMOLECULAR POTENTIAL IN LIQUID ARGON. **Phillips, James T.; Linderstrom-Lang, Carl U.; Bigeleisen, Jacob (Univ. of Rochester, N. Y.). Contract AT(30-1)-3999. J. Chem. Phys.; 56: No. 10, 5053-62(15 May 1972).**

The statistical thermodynamic treatment of the equilibrium between a nonideal liquid mixture of isotopes and a vapor phase is extended to include isotope effects on the equation of state of the gas. The result is particularly simple when the isotopic partition functions in a given phase are compared at the same molar volume. The isotope fractionation factor α for $^{36}Ar/^{40}Ar$ between liquid and vapor was measured from the triple point to the critical temperature. The results are compared with previous vapor pressure data, which cover the range 84 to 102°K. Although the agreement is within twice the statistical scatter of the present data, the present results for the $\ln\alpha$ are systematically 5% lower than calculations from vapor pressure data. It is shown that $T^2 \ln\alpha$ is a linear function of $(\rho_c - \rho_g)$, the density difference between the liquid and vapor, in the range 84 to 120°K. The fractionation factor approaches zero at the critical temperature with a nonclassical critical index equal to 0.42 ± 0.02. $\langle\nabla^2U_c\rangle/\rho_c$ in liquid argon is derived from the experimental fractionation data and calculations of $\langle\nabla^2U_g\rangle/\rho_g$ for a number of potential functions for gaseous argon. (auth)

33128 FORCE CONSTANTS OF THE METABORATE ION IN ALKALI HALIDES. **Decius, J. C.; Becker, C. R.; Fredericks, W. J. (Oregon State Univ., Corvallis). J. Chem. Phys.; 56: No. 10, 5189-90(15 May 1972).**

The ν_2 region of the spectrum of single crystals of KBr and KCl doped with metaborate was examined in order to find the difference frequencies (hot bands) for the transitions $01^10 \rightarrow 10^00$ and $01^10 \rightarrow 02^00$ that are infrared allowed and have been detected in cyanate studies. The isotopic species reported include $^{10}B^{16}O_2^-$, $^{11}B^{16}O_2^-$. The results found were in good agreement with the prediction based upon the transferred anharmonicity correction. (D.H.M.)

33129 DIPOLE MOMENT OF ICl. **Herbst, Eric; Steinmetz, Wayne (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 56: No. 11, 5342-6(1 Jun 1972).**

The $J = 2 \leftarrow 1$ microwave spectra of $I^{35}Cl$ and $I^{37}Cl$ were measured for the v = 0 and v = 1 vibrational levels. The dipole moment $\mu(v = 0) = 1.24 \pm 0.02$ D is determined by Stark effect measurements. Improved values of the rotational and quadrupole coupling constants are obtained and the iodine nuclear spin-rotation constant is determined. (auth)

33130 DOES THE SOLVENT DEUTERIUM ISOTOPE EFFECT DEPEND UPON THE ACID STRENGTH? **Ohtaki, Hitoshi; Maeda, Masunobu (Tokyo Inst. of Tech.). Z. Naturforsch.; 27b: No. 5, 571-2(May 1972).**

Plots of solvent deuterium isotope effects (ΔpK) vs pK (in H_2O) are shown for four different types of acids. No systematic trend was observed. The independence of ΔpK from pK was substantiated. (M.C.G.)

33131 KINETIC ISOTOPE EFFECT OF DEUTERIUM IN THE FORMATION OF SULFONAMIDES. **Litvinenko, L. M.; Maleeva, N. T.; Savelova, V. A.; Kovach, T. D. (Donetsk State Univ., USSR). Zh. Obshch. Khim.; 41: No. 12, 2615-18(Dec 1971). (In Russian).**

The kinetics of the reaction of aromatic amines (p-anisidine, m-nitroaniline) and their N,N-dideutero-substituted analogs with halide derivatives of p-toluenesulfonic acid (the acid chloride, acid bromide) were studied in the solvent nitrobenzene at 25°C. The ratios k_H/k_D were determined, and it was concluded that evidence for a direct, primary, kinetic isotope effect was lacking. (K.S.W.)

Isotope Exchange and Isotope Separation

33132 (AEEW-R-717) MAXIMUM THEORETICAL H/D SEPARATION FACTOR AND ITS APPLICATION TO REAL SYSTEMS. **Rowland, P. R. (Atomic Energy Establishment, Winfrith (England)). Jan 1971. 41p. Dep. NTIS (U. S. Sales Only).**

General equations for the calculation of electrolytic H/D separation factors were set up, using the method of reduced partition functions. The equations apply to any isotopic ratio in the electrolyte and to either a discharge reaction or a bimolecular reaction as the rate step. The maximum hypothetical separation factor, S_{max}, was obtained in each case by allowing the transition state complexes to approach indefinitely close to the free-atom state. (UK)

33133 (AEEW-R-718) ELECTROLYTIC H/D SEPARATION FACTOR–AGREEMENT OF EXPERIMENT WITH THE HYPOTHETICAL MAXIMUM VALUE. **Rowland, P. R. (Atomic Energy Establishment, Winfrith (England)). Jan 1971. 43p. Dep. NTIS (U. S. Sales Only).**

Two methods are described for obtaining H/D electrolytic separation factors under clearly defined experimental conditions. The first consists in continuously maintaining a fresh cathode surface by depositing cathode material onto it while hydrogen evolution is in progress (the scavenging technique). The second consists in displacing other surface impurities by the deliberate use of bath additives, which adsorb onto the cathode so that the surface is maintained in a definite, reproducible state (the displacement technique). When both methods are combined in hot alkaline electrolytic baths having iron electrodes, certain of the additives investigated (EDTA and urea) thereafter give maximal, reproducible experimental separation factors. Such baths are said to be optimised and optimisation persists even when the baths are subsequently operated at low temperatures. (UK)

33134 (K-L-3054(Rev.1)) PHOTOCHEMICAL ISOTOPE SEPARATION AS APPLIED TO URANIUM. Farrar, R. L., Jr.; Smith, D. F. (Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.). 15 Mar 1972. Contract W-7405-eng-76. 45p. Dep. NTIS.

Past and present work on the photochemical isotope separation process is reviewed and its present potential to the uranium isotope separation industry is evaluated. The photochemical separation of mercury isotopes is reviewed. Isotope shifts were identified for uranium but at either a very high temperature or a temperature below liquid nitrogen. Neither of these seemed suitable for a practical isotope separation process. At room temperature a gross isotope shift was identified for UF_6 at 16.0 μ in the infrared. There might be some fine structure, as yet unresolved, that could, in theory, be utilized. (M.C.G.)

33135 DEVICE FOR HEATING UNDER HIGH PRESSURE. Normand, Alfred; Lesur, Pierre (to Societe Chimique des Charbonnages. Commissariat a l'Energie Atomique. L'Air Liquide, Societe pour l'Etude et l'Exploitation des Procedes Georges Claude. Compagnie des Constructions Mechaniques Procedes Sulzer). French Patent 2,074,696. 8 Oct 1971. Filed 19 Jan 1970. (In French).

An apparatus for monothermally preparing ammonia gas and highly deuterated ammonia gas in two coupled isotopic exchange units is described. Part of the nitrogen necessary for the synthesis of the ammonia gas is introduced below the extraction tower, which serves to extract deuterium from the nitrogen—hydrogen mixture introduced into the installation. In order to supply the calories necessary for the cracking of the NH_3, either a nitrogen—hydrogen mixture (at the exit of the deuterium extraction tower) or ammonia gas is used, air being employed as the comburent. Nitrogen from the air is also used in the mixture introduced into the NH_3 synthesis unit. (France)

33136 ISOTOPE EFFECTS IN THE HYDRATED STRUCTURE OF SOLID AND AQUEOUS COPPER SULFATE. Maiwald, B.; Heinzinger, K. (Max-Planck-Institut fuer Chemie, Mainz). Z. Naturforsch.; 27a; No. 5, 819-26(May 1972). (In German).

The fractionation of oxygen isotopes of water molecules in $CuSO_4 \cdot 5\ H_2O$ and in aqueous solutions of copper sulfate was measured at 25°C. In the total crystal water (G) three kinds of water can be distinguished by their binding: (1) the bisector of the two lone pairs directed towards the copper ion (K_1), (2) one of the lone pairs directed towards the copper ion (K_2), and (3) the two lone pairs directed towards two hydrogen atoms of water molecules coordinated with the copper ion (L). The water molecules in the copper sulfate solution are considered either hydration water (HW) or bulk water (FW). Defining $\alpha_{A-B} = (^{18}O/^{16}O)_A / (^{18}O/^{16}O)_B$ the following results were obtained: $\alpha_{K_1-G} = 0.9943 \pm 0.0003$, $\alpha_{HW-FW} = 1.0207 \pm 0.0004$, $\alpha_{K_2-G} = 0.9886 \pm 0.0003$, $\alpha_{G-FW} = 1.0120 \pm 0.0003$, $\alpha_{L-G} = 1.034 \pm 0.002$. There remains some doubt if the values attributed to α_{K_1-G} and α_{K_2-G} have to be interchanged. The elementary cell of $CuSO_4 \cdot 5\ H_2O$ consists of two molecules. Four molecules of K_1-water are coordinated with one copper ion and four molecules of K_2-water are coordinated with the second copper ion. The remaining two water molecules are of L-type. It was concluded from the results that on dehydration at temperatures below 50°C first one copper ion loses its water and then the other. There is some doubt as to which group breaks up first. In addition, the results show that the L-type water becomes quantitatively the water of the monohydrate in agreement with the conclusions drawn from the results of the fractionation of the hydrogen isotopes in $CuSO_4 \cdot 5\ H_2O$. It is demonstrated that, by considering only the overall fractionation of the oxygen or hydrogen isotopes between total crystal water and the saturated solution, wrong conclusions about the crystallization process could be drawn. In the case of $CuCl_2$ solutions, it was shown that the separation factor α_{HW-FW} is sensitive towards changes in the structure of the solution. (auth)

33137 USE OF A COMBINED GAS CHROMATOGRAPH—MASS SPECTROMETER TO STUDY THE DEUTEROLYSIS OF NEOPENTANE OVER IRON FILMS. Dowie, R. S.; Kemball, C.; Kempling, J. C.; Whan, D. A. (Univ. of Edinburgh). Proc. Roy. Soc. (London). Ser. A; 327, No. 1571, 491-500(25 Apr 1972).

The application of a combined gas chromatograph-mass spectrometer to catalytic reactions is described, particularly with reference to the reactions between deuterium and hydrocarbons over metal films. The analysis was complicated by partial separation of hydrocarbon isotopes in the gas chromatograph and different sensitivities of the equipment to "light" and "heavy" methane. For the reaction of neopentane, indexed as 2,2-dimethylpropane, with deuterium over iron films exchange occurs 2.0 times more rapidly than hydrogenolysis and yields $(CH_3)_3(CH_2D)C$ and $(CH_3)_3(CD_3)C$ as the only initial deuterated neopentanes. Stepwise exchange occurs at 1.5 times the rate of multiple exchange. The absence of exchange products originating from an $\alpha\gamma$-adsorbed intermediate suggests that $\alpha\gamma$ species are irreversibly adsorbed and lead directly to carbon—carbon bond rupture. The hydrogenolysis gives extensive degradation of neopentane, leading to 99% methane and small quantities of isobutane. The hydrogenolysis products were completely exchanged. (auth) (UK)

33138 ISOTOPIC EFFECTS OF CALCIUM BY ION EXCHANGE USING DOWEX A1 RESIN. Heumann, Klaus G. (Technische Hochschule, Darmstadt, Ger.). Z. Naturforsch.; 27b: No. 5, 492-7(May 1972). (In German).

The isotopic effect of calcium was determined in several heterogeneous systems with the chelating resin Dowex Al. In one column experiment the dependence of the isotopic effect on the concentration of the hydrochloric acid as the eluent was studied. In the case of a 10^{-2} M HCl the isotope ^{48}Ca was enriched in the solution. In the case of a 10^{-4} M HCl an enrichment of the isotope ^{40}Ca was observed in the solution. This inversion of the isotopic effect can be explained by the formation of a calcium complex in the chelating resin occurring in a 10^{-4} M HCl solution. In another column experiment calcium was eluted with an EDTA solution. An enrichment of the heavier calcium isotopes was found in the solution. In this case only a small separation factor was found, because calcium forms a complex in the Dowex Al resin as well as in the EDTA solution. In a static ion exchange experiment on the system $Ca^{2+}_{(Dowex\ Al)}/Ca^{2+}_{(aq)}$ the elementary separation factor was measured. The heavier isotopes were enriched in the solution. For the ratio $^{44}Ca/^{40}Ca$ the elementary separation factor was found to be 1.0137, in the case of $^{48}Ca/^{40}Ca$ the separation factor was 1.0214. (auth)

Radiation Chemistry

Refer also to abstracts 33215, 33447, 33528, 33580, 33669, and 35240.

33139 (ORO-4059-2) RADIATION CHEMISTRY OF HIGH POLYMERS. Progress Report No. 2, April 1, 1971—April 15, 1972. Dole, Malcolm; Welch, Robert A. (Baylor Univ., Waco, Tex.). 15 May 1972. Contract AT(40-1)-4059. 15p. Dep. NTIS.

Research progress is reported on: influence of polyethylene morphology on free radical production and decay rates in irradiated polyethylene, determination of the solubility of hydrogen in irradiated polyethylene, studies of ESR spectra in irradiated polyethylene, and kinetics of decay of the doublet free radical in irradiated POM at elevated temperatures. (M.C.G.)

33140 (SC-T-722491) EFFECT OF GAMMA RADIATION ON THE REDUCTION OF IRON OXIDES WITH HYDROGEN. Ansary, M. S.; Tobgy, A. H.; Ezz, S. Y. Translated for Sandia Labs., Albuquerque, N. Mex., from Hutn. Listy; 21: No. 9, 596-8 (1966). 9p. Dep. NTIS.

The reduction of ferric oxide by hydrogen is accelerated by prior irradiation of the oxide with γ rays. The effect of irradiation becomes more marked as the radiation dose is increased. The influence of radiation is quite marked only at lower temperatures (up to about 400°C), and gradually decreases with rising temperature, becoming completely negligible at approximately 600°C. The reduction of irradiated pure ferric oxide differs from that of non-irradiated oxide specimens only in the initial stages of the process ($Fe_2O_3 \rightarrow Fe_3O_4$). Gamma irradiation of iron ore has a negligible effect at technologically significant reduction temperatures, and it may therefore be concluded that the described procedure is of no industrial importance with respect to the reduction of iron ores with gases. (For abstract from original language see NSA 22: 12480.) (auth)

33141 PRODUCTION OF EXCITED STATES BY LASERS AND IONIZING RADIATION. Thomas, J. K. (Univ. of Notre

Dame, Ind.). Rec. Chem. Progr.; 32: No. 3, 145-63(1971). (COO-37-787).

The fundamental processes taking place in the low-energy (<10 eV) excitation of a molecule and the high-energy (>100 eV) excitation of systems are described. The techniques of nsec laser photolysis, and nanosecond and picosecond pulse radiolysis together with low temperature irradiations are used to illustrate the arguments. Two model liquids are used, cyclohexane, or 3-methylhexane, and cumene. In alkanes, the excited states are formed mainly by ion neutralization, while in the aromatic systems, direct excitation to a variety of energy states could well explain the observed data. (auth)

33142 KINETICS OF RADIATION-INDUCED GRAFTING REACTIONS. I. POLYETHYLENE–STYRENE SYSTEMS. Yasukawa, T. (Tohoku Univ., Sendai); Takahashi, T.; Murakami, K.; (and others). J. Polym. Sci., Part A-1; 10: No. 1, 259-73(Jan 1972).

By means of bromine labeling and ESR, the grafting reactions of styrene onto preirradiated polyethylene were investigated. Not all the radicals produced by irradiations participate in grafting reactions all together, but they are rendered active bit by bit by the swelling of crystalline parts of polyethylene. The growing rates for polystyryl graft chains at 20°C decrease from 4 monomer units/active site/sec to one-fourth the initial value after 100 min. On the contrary, the average lifetimes increase from $<10^3$ sec to $>2.6 \times 10^3$ sec. The number-average molecular weight of graft chains also increases with reaction times and rises to 3.5×10^5 after 90 min at 20°C. (auth)

33143 GRAFTING OF ACRYLIC ACID ONTO RADIATION-PEROXIDIZED POLYPROPYLENE FILM IN THE PRESENCE OF FERROUS ION. O'Neill, Thomas (Aktiengesellschaft fuer Industrielle Forschung und Strahlennutzung, Schwerzenbach, Switzerland). J. Polym. Sci., Part A-1; 10: No. 2, 569-80 (Feb 1972).

Acrylic acid was grafted from aqueous solution onto 70 μ isotactic polypropylene film previously peroxidized by irradiating in air with both 400-keV electrons and γ radiation from a ^{60}Co source. Ferrous ion was used to induce the redox decomposition of the macromolecular peroxy species at temperatures between 0 and 40°C. The effect of low $[\mathrm{Fe^{2+}}]$ is to increase grafting rates, but that at $[\mathrm{Fe^{2+}}] > 8 \times 10^{-4}$ molal the retarding effect of the reducing ion becomes increasingly important. At constant $[\mathrm{Fe^{2+}}]$ a pronounced maximum in rate is observed at around 50 wt % of acrylic acid; this may be related to increased swelling of the polymer matrix at this point. The initial rate of grafting increases as the square root of the preirradiation dose and, in the preirradiation dose rate range, 1.6–8.0 Mrad/sec, is independent of the dose rate. The grafting rate during the later stages of the reaction, however, increases as the preirradiation dose rate decreases. In the temperature range 0 to 40°C, the overall activation energy is 19 kcal/mole; from this value, the activation energy of initiation was estimated to be around 20 kcal/mole. (auth)

33144 γ-RADIATION-INITIATED EMULSION POLYMERIZATION OF n-BUTYL ACRYLATE AND OF METHYL METHACRYLATE. O'Neill, Thomas; Hoigne, Juerg (Aktiengesellschaft fuer Industrielle Forschung und Strahlennutzung, Schwerzenbach, Switzerland). J. Polym. Sci., Part A-1; 10: No. 2, 581-93(Feb 1972).

The γ-radiation-initiated polymerization of n-butyl acrylate (BA) and of methyl methacrylate (MMA) in aqueous emulsions stabilized with sodium lauryl sulfate (SLS) was investigated. The reaction rate, as measured by a nonabsolute thermocouple technique, varies as the square root of emulsifier concentration for both monomers. In the case of BA, the dose rate exponent of the reaction rate is 0.7 ± 0.3, whereas the corresponding value for MMA is approximately 0.4. The overall activation energy of the BA polymerization is close to zero, whereas for MMA a value of 4.8 ± 2.1 kcal/mole was found. The poly(butyl acrylate) molecular weight was effectively independent of soap concentration and of dose rate but decreased as the reaction temperature increased in the range 30 to 70°C. The general conclusion drawn is that these radioinduced emulsion polymerizations differ little from conventionally initiated systems insofar as the reaction kinetics are concerned. Poly(butyl acrylate-g-methyl methacrylate) copolymers were prepared by a direct irradiation method involving a poly(butyl acrylate) prepolymer seed latex. Some physical properties of this material were examined. (auth)

33145 RADIATION CHEMISTRY OF CARBOHYDRATES. XV. THE ROLE OF RADIOLYSIS PRODUCTS OF WATER DURING THE DECOMPOSITION OF AQUEOUS SOLUTIONS OF LACTOSE. Kudryashov, L. I.; Yarovaya, S. M.; Bortsova, E. I.; Sharpatyi, V. A. Zh. Obshch. Khim.; 41: No. 10, 2298-2305(Oct 1971). (In Russian).

The radiolysis of neutral and alkaline solutions of lactose at room temperature and at 77°C was studied with ^{60}Co gamma radiation. Solutions were variously saturated with N_2, O_2, and N_2O in order to ascertain the effect of dissolved gases. The chief radiolysis products were glucose, galactose, malondialdehyde, and a desoxy keto sugar. (K.S.W.)

33146 EFFECT OF IRRADIATION OF ORGANIC PHOSPHORS ON THEIR PHOSPHORESCENCE DECAY KINETICS. Kotarski, J. (Medical Academy, Danzig). Acta Phys. Pol.; A41: No. 4, 403-10(Apr 1972).

Trypaflavin-gelatin gels were submitted to intense white light and ionizing radiation and successive α-phosphorescence decay curves were recorded. Each decay curve was obtained after a single exciting flash by means of a specially designed phosphoroscope. It was found that after intense irradiation with white light the mean decay time of the afterglow is prolonged considerably, then slowly drops until it reaches, after several minutes, the value pertinent to the unirradiated phosphor. This effect is strong in gelatin solutions activated with trypaflavin, and much weaker when agar-agar and poly(vinyl alcohol) are the solvents. The time-dependence of the phosphorescence quantum yield after irradiation was measured. Experimental results are compared with the theoretical relationship between relative quantum yield and quencher concentration found on the basis of the shell-model theory of the luminescence center. It is presumed that the changes in the mean decay time and phosphorescence yield are a result of quenching of excited centers by molecular oxygen dissolved in the solution. (auth)

33147 γ-INDUCED SYNTHESIS OF β-CHLOROALKYLDICHLOROPHOSPHINES. Zagorets, P. A.; Shostenko, A. G.; Dodonov, A. M. (Moscow Chemical-Tech. Inst.). Zh. Obshch. Khim.; 41: No. 10, 2171-3(Oct 1971). (In Russian).

Synthesis of a series of β-chloroalkyldichlorophosphines was accomplished by irradiating a mixture of PCl_3 and a liquid olefin at temperatures of from 30 to 60°C for 10 hr with ^{60}Co gamma radiation. In the following equation, R, R', and R'' represent H, CH_3, C_2H_5, C_3H_7, C_4H_9, C_5H_{11}, or C_6H_{13}: $PCl_3 + RR'C = CR''H \rightarrow RR'CClC(PCl_2)R''H$. (K.S.W.)

33148 EFFECT OF γ-RADIATION ON THE PHYSICO-CHEMICAL PROPERTIES AND MOLECULAR STRUCTURE OF COPOLYMERS OF ETHYLENE WITH VINYL ACETATE AND VINYL CARBONATE. Leshchenko, S. S.; Soboleva, N. S.; Egorova, Z. S.; Terteryan, R. A.; Karpov, V. L. Vysokomol. Soedin., Ser. A; 14: No. 3, 620-7(Mar 1972). (In Russian).

The effect of ^{60}Co γ radiation on the physicomechanical properties and structure of the E – VA (ethylene–vinyl acetate) and E – VC (ethylene–vinyl carbonate) copolymers was studied. The predominant radiochemical process in E – VA copolymers is radioinduced crosslinking. The optimum physicomechanical properties for E – VA copolymers are observed on irradiation with the dose up to 5 to 10 Mrad. For E – VC copolymers the optimum radiation dose is 75 Mrad. Increase in the polar groups content in the copolymer led to retardation of the radiative crosslinking process and increase of the degradation probability. The ir spectra show that the radiative crosslinking in these copolymers occurs at the tertiary carbon atoms and methylene groups of the main chain. In E – VA copolymers the primary carbon atoms of the acetate groups also participate in radiative crosslinking. An impairment of the strength properties observed is the result of the rupture of the ether bonds C – O and of the O – CO bond at the carbonyl group, as well as of the rupture of the C – C bond of the main chain. (auth)

33149 ACID–BASE PROPERTIES OF THE RADICALS PRODUCED IN THE PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS OF BENZOIC ACID. Simic, M.; Hoffman, Morton Z. (Army Natick Labs., Mass.). J. Phys. Chem.; 76: No. 10, 1398-1404 (11 May 1972).

Hydrated electrons, produced by pulse radiolysis in aqueous solution, react with benzoic acid ($k = 1.6 \times 10^{10}$ M^{-1} sec^{-1}) and benzoate ($k = 3.2 \times 10^9$ M^{-1} sec^{-1}) to give transient species with pH-dependent optical absorption spectra. At pH 3.8, $\lambda_{max} < 290$ ($\epsilon_{max} > 16{,}000$ M^{-1} cm^{-1}) and 420 (1600); at pH 9.1, λ_{max} 310 (25,000) and 435 nm (5200); at pH 13.2, λ_{max} 322 (27,000) and 445 nm (8000). The dependence of the spectra on pH shows that the electron adduct transient species have pK$_a$ values of 5.3 and 12.0. An extended Hückel molecular orbital calculation shows that the electron adds to the molecular π system with a large fraction of the electron density localized on the carboxylate carbon. Protonation takes place on the carboxylate oxygen atoms, not on the aromatic ring, producing absorption spectra that are completely different than that observed for the addition of H atoms to benzoic acid (λ_{max} 350 nm, $\epsilon_{max} < 4200$ M^{-1} cm^{-1}) forming the cyclohexadienyl radical, $\cdot C_6H_5(H)CO_2H$. The electron adduct can best be represented as a substituted benzyl radical, $C_6H_5C(OH)_2$. Electron addition to benzenesulfonate, on the other hand, yields a spectrum which resembles that of a cyclohexadienyl radical (325 nm, 3700 M^{-1} cm^{-1}), $\cdot C_6H_5(H)SO_3^-$. Hydroxyl radicals add to the benzoate aromatic ring to yield $\cdot C_6H_5(OH)CO_2H$ (350 nm, 3800 M^{-1} cm^{-1}) and $\cdot C_6H_5(OH)CO_2^-$ (330 nm, 3800 M^{-1} cm^{-1}) with $pK_a = 4.4$. (auth)

33150 FURTHER EVIDENCE ON FREE-RADICAL DECAY IN γ-IRRADIATED ALKYL HALIDE AND HYDROCARBON–ALKYL HALIDE GLASSES. Roy, Colin R.; Willard, John E. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1715. J. Phys. Chem.; 76: No. 10, 1405-10(11 May 1972).

Experimental information on factors which affect the decay rates of free radicals produced from alkyl halides in hydrocarbon glasses and in pure glassy and polycrystalline alkyl halides by γ irradiation is reported. Effects of radical structure are illustrated by differences in the decay rates of the isomeric butyl radicals in solutions of the butyl chlorides in glassy 3-methylpentane-d_{14} (3MP-d_{14}) and by a decrease in decay rates with increasing chain length of alkyl radicals produced from n-alkyl iodides in 3MP-d_{14}. Effects of matrix structure are illustrated by the decay rates of the radicals in glassy ethyl, n-propyl, n-butyl, and n-amyl halides ($RCl < RBr < RI$) and by comparison of the relative decay rates of the isomeric butyl radicals in the glassy parent chloride matrices, with the relative rates in glassy 3MP-d_{14}, C_2H_5, CH_3CD_2, CD_3CH_2, and C_2D_5 radicals decay at the same rate in glassy 3MP-d_{14} but at different rates in their parent ethyl iodide matrices, the rates decreasing with the extent of deuteration. When γ-irradiated polycrystalline C_2H_5I at 77°K, giving the previously studied complex 1000-G ESR spectrum, is warmed to 125°K, the central spectrum, attributable to C_2H_5 radicals, grows slowly with accompanying decrease of the lines on the wings. Photobleaching in the 375-nm region causes a decrease in all parts of the spectrum. On increase of the temperature to 134°K in the dark, the central signal increases by threefold in 10 min, accompanied by a decrease of the signal on the wings and followed by rapid decay of the central signal, indicating that the growth reaction does not have a sharp temperature threshold as previously suggested. Radical decays in polycrystalline ethyl and propyl chlorides and bromides have been compared. (auth)

33151 FREE RADICAL FORMATION IN HYDROCARBON CRYSTALS BY γ IRRADIATION. II. RELATIVE YIELDS OF ISOMERIC ALKYL BY ELECTRON SPIN RESONANCE. Lund, Anders (Swedish Research Council's Lab., Studsvik). J. Phys. Chem.; 76: No. 10, 1411-15(11 May 1972).

Single crystals of the lower n-paraffins containing 4 to 16 carbon atoms give rise to ESR spectra from secondary alkyl $CH_3\dot{C}HCH_2R$ (I) and $R'CH_2\dot{C}HCH_2R''$ (II) after γ irradiation at 77 or 195°K. The conformation of radicals formed in butane differs somewhat from those trapped in the long-chain n-alkane crystals. The relative yields of I and II were estimated by a least-squares fit. The predominant formation of I is shown to be inconsistent with estimates based on the analysis of final products. Possible explanations are discussed in terms of reactions along the particle tracks, and ionic mechanisms. A neutralization process is suggested which would lead to the preferential formation of radicals of type I by reason of the charge distribution in the positive radical ion primarily formed. (auth)

33152 PULSE RADIOLYSIS AND POLAROGRAPHY. II. USE OF AN ON-LINE COMPUTER IN THE DETERMINATION OF THE HALF-WAVE POTENTIALS OF SHORT-LIVED INORGANIC RADICALS. Lilie, Jochen (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 76: No. 10, 1487-92(11 May 1972).

An on-line computer was used in the polarographic determination of the half-wave potentials of a number of short-lived inorganic radicals. The radicals are formed by 2-μsec pulses of 3-MeV electrons in the environment of a dropping mercury electrode. The current changes resulting from the reduction or oxidation of the radicals are measured at different times after the beam as a function of the applied voltage and the information obtained is accumulated in the computer memory for averaging and data processing purposes. The half-wave potentials of radicals formed by the reaction of the hydroxyl radical with halogenides and pseudohalogenides were measured. These radicals were reduced at the dropping mercury electrode, with reduction of Br_2^- ($E_{1/2} = -0.57$ V (sce)) the easiest. Observations on certain other inorganic radicals (e.g., HPO_2^-) are also reported. It was demonstrated, by comparison with charge-transfer reactions known from ESR measurements, that the half-wave potentials of the radicals can be used to decide whether a reduction of the radicals by a solute is energetically possible or not. All examined radicals with half-wave potentials more positive than −0.8 V are reduced by nitromethane in its alkaline form and all radicals with values more negative than −0.9 V are not reduced. (auth)

33153 TEMPERATURE DEPENDENCE OF THE DRIFT MOBILITY OF ELECTRONS IN GLASSY 10 M SODIUM HYDROXIDE ICE. Huang, Timothy; Eisele, Ignatz; Kevan, Larry (Wayne State Univ., Detroit). Contract AT(11-1)-2086. J. Phys. Chem.; 76: No. 10, 1509-10(11 May 1972).

The drift mobility measurements on electrons in glassy 10M NaOH ice are reported that confirm the applicability of a band model to this system. The temperature dependence of the mobility in the high-field region shows that ionic species scattering as well as lattice phonon scattering occurs. (D.H.M.)

33154 RADIATION-INDUCED POSTPOLYMERIZATION OF TRIOXANE IN THE SOLID STATE. IV. COPOLYMERIZATION OF TRIOXANE WITH DIOXOLANE. Ishigaki, Isao; Ito, Akihiko; Hayashi, Koichiro (Japan Atomic Energy Research Inst., Takasaki). J. Polym. Sci., Part A-1; 10: No. 3, 751-62(Mar 1972).

The radio-induced postpolymerization of trioxane with 1,3-dioxolane was investigated. Trioxane and 1,3-dioxolane were carefully purified in a rigorously dry, high-vacuum system. Trioxane can be easily copolymerized with 1,3-dioxolane to give a copolymer having high molecular weight and excellent thermal stability. Typically, the isothermal weight loss after heating for 60 minutes under nitrogen at 222°C was 3.5% for a copolymer of trioxane and 1.0 wt % 1,3-dioxolane preirradiated with a dose of 1.0×10^5 Rad. The thermal stability of the copolymer was scarcely affected by the polymerization temperature and time, although it decreased slightly with increasing preirradiation dose. The dependences of the yield and inherent viscosity of the polymer on the preirradiation dosage, polymerization temperature, and time were quite similar to those found for the homopolymerization of trioxane. The results were analyzed by using the kinetic scheme previously reported, and it was found that no chain transfer reaction occurs in this system. These results are discussed in comparison with those of homopolymerization reported previously. (auth)

33155 OBSERVATION OF PENTADS IN DEUTERATED POLYACRYLONITRILE BY NMR SPECTROSCOPY. Matsuzaki, Kei (Tokyo Univ.); Okada, Munehisa; Goto, Kojitsu. J. Polym. Sci., Part A-1; 10: No. 3, 823-8(Mar 1972).

The deuterium-decoupled methine proton spectra of polyacrylonitrile-β,β-d_2 were measured at 156°C in dimethyl-d_6 sulfoxide solution. Splittings of triad peaks caused by pentad sequences were observed. The isotactic triad resonance was resolved into three peaks and the heterotactic resonance into two peaks, while the syndiotactic resonance was unresolved or resolved into three peaks. The splittings were assigned by comparing the probability of each pentad sequence with observed intensities. The pentad signal shifted to the higher magnetic field with increasing number of meso configurations as neighbors of the central triad. It was observed that the pentad of atactic polyacrylonitrile-β,β-d_2 obeyed Bernoullian statistics but that of isotactic polymer obtained by γ-irradiation of the canal complex seemingly obeyed first-order Markov statistics. (auth)

33156 RADIATION-INDUCED GRAFTING OF STYRENE VAPOR TO POLYETHYLENE. Kamel, Ihab; Machi, Sueo; Silverman, Joseph (Univ. of Maryland, College Park). J. Polym. Sci., Part A-1; 10: No. 4, 1019-29(Apr 1972).

The radio-induced grafting of styrene vapor to low-density polyethylene film of 0.063-mm thickness was studied at 23°C at a dose rate of 1.98×10^4 rad/hr. The concentration, C, of monomer in the film was measured as a function of pre-irradiation exposure time to monomer vapor. The concentration-dependent diffusion coefficient of styrene in polyethylene was calculated to be $4.9 \times 10^{-9} \exp\{2.0C/C_0\}$ cm^2/sec, where C_0 is the saturation concentration of styrene in the film, and a linear boundary diffusion coefficient for styrene vapor into polyethylene film was found to be 2.0×10^{-7} cm/sec. The rate of grafting was determined as a function of the concentration of styrene absorbed in the film. The maximum graft yield was obtained with an initial styrene concentration in the film of 4 wt %. Under conditions of low initial monomer concentration, the grafting rate increases with irradiation time. The results are compared with previously published data on grafting of polyethylene for methanol–styrene solutions. They are explained in terms of the viscosity of the amorphous region as a function of styrene content and the resistance to the diffusion of monomer at the film–vapor interface. (auth)

33157 PROPAGATING RADICAL IN COPOLYMERIZATION OF METHACRYLIC ACID WITH γ-IRRADIATED CELLULOSE.

Hinojosa, Oscar; Arthur, Jett C. Jr. (Dept. of Agriculture, New Orleans). J. Polym. Sci., Part B; 10: No. 3, 161-5(Mar 1972).

The ESR spectrum of living poly(methacrylic acid) radicals is given. Trapped cellulosic radicals were used as the initiator of graft copolymerization of methacrylic acid with γ-irradiated cotton. Copolymerization was stopped, the ESR spectrum recorded, and the copolymerization re-initiated. (M.C.G.)

33158 ESR OBSERVATION OF TRANSIENT ACYL RADICALS IN POLYETHYLENE IRRADIATED IN THE PRESENCE OF CO. Tsuji, Kozo; Takeshita, Takuo (Sumitomo Chemical Co., Ltd., Osaka). J. Polym. Sci., Part B; 10: No. 3, 185-8 (Mar 1972).

CO molecules combine with alkyl radicals in irradiated polyethylene at about −120°C to form acyl radicals as a transient species during warmup from −196°C to room temperature. Polyethylene was irradiated with electron beams in the presence of CO. ESR spectra were recorded. These spectra indicated the presence of acyl radicals. (M.C.G.)

33159 HYDROGEN ATOM ABSTRACTION BY METHYL RADICALS IN γ-IRRADIATED CRYSTALLINE METHYL ISOCYANIDE AT 77 TO 125°K. Wang, Jih-tzong; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Amer. Chem. Soc.; 94: No. 9, 2930-4(3 May 1972). (ORO-2968-65).

The elementary reaction $CH_3\cdot + CH_3NC \rightarrow CH_4 + \cdot CH_2NC (k_2)$ was studied by ESR in γ-irradiated crystalline CH_3NC between 77 and 125°K. First-order kinetics apply and good agreement was obtained between the rate constants calculated from $CH_3\cdot$ disappearance and from $\cdot CH_2NC$ appearance, thereby verifying the course of the reaction. The temperature dependence of the reaction rate constant shows an anomalous Arrhenius behavior, the apparent activation energies being 1.4 and 4.5 kcal mol^{-1} at 90 and 120°K, respectively. The corresponding process of deuterium atom abstraction from CD_3NC is too slow to be measured in this temperature range, and $CD_3\cdot$ radicals in CD_3NC disappear above 120°K by other processes. It is estimated from the results that the kinetic isotope effect, k_2^D/k_2^H, at 110°K is at least 1.1×10^3, which is more than the maximum classical effect (1.9×10^2) calculated according to the difference in initial zero point energies. These experimental results provide strong evidence for a large contribution from quantum mechanical tunneling in this H-atom abstraction reaction at low temperatures. (auth)

33160 CORRELATION BETWEEN EPR AND POSITRON ANNIHILATION MEASUREMENTS ON γ-IRRADIATED ACETYL METHIONINE. Eldrup, M.; Lund-Thomsen, E.; Mogensen, O. (Danish Atomic Energy Commission Research Establishment, Risoe). J. Chem. Phys.; 56: No. 10, 4902-6 (15 May 1972).

The dose dependence of the relative EPR signal intensity and positron lifetime spectrum was measured for γ-irradiated acetylmethionine in the dose range from 0 to 30 Mrad. Angular correlation measurements were performed for the doses 0 and 30 Mrad. The result of the irradiation was the creation of EPR centers and inhibition of positronium formation. For one sample, irradiated with a dose of 30 Mrad, EPR and positron lifetime spectra were followed over a period of 50 days after the irradiation. The inhibiting effect and the EPR signal intensity decreased with time. No simple correlation could be established between the number of EPR centers and the positron annihilation data, but other possible explanations are discussed. (auth)

33161 PULSE RADIOLYSIS OF LIQUIDS AT HIGH PRESSURES. II. DIFFUSION-CONTROLLED REACTIONS OF THE HYDRATED ELECTRON. Hentz, Robert R.; Hansen, Earl M. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 56: No. 9, 4485-8(1 May 1972). (COO-38-823).

For each of 11 presumably diffusion-controlled reactions of e^-_{aq}, absolute specific rates were determined by pulse radiolysis at four to seven pressures from atmospheric to 6.4 kbar. The ratio of specific rate at 6.4 kbar to that at 1 atm, followed by the corresponding activation volume in milliliters $mole^{-1}$, is given in parentheses for each of the reactants: O_2 (1.05, −0.2), H_2O_2 (0.88, 0.5), acrylamide (0.90, 0.4), benzamide (0.95, 0.2), p-nitrophenol (0.84, 0.7), NO_3^- (1.00, 0.0), $S_2O_8^{2-}$ (1.07, −0.3), $Cr(C_2O_4)_3^{3-}$ (1.32, −1.1) Tl^+ (0.74, 1.2), Cd^{2+} (0.75, 1.1), Sm^{3+} (0.86, 0.6). The Debye equation for specific rate of a diffusion-controlled reaction is used for analysis of the results. Such an analysis suggests that the diffusion coefficient of e^-_{aq} changes negligibly (compared to normal ions and molecules) and possibly increases with increase in pressure to 6.4 kbar. With the result for reaction of e^-_{aq} with NO_3^-, certain activation volumes obtained in previous γ-radiolysis studies (by assumption of an activation volume for the NO_3^- reaction) are corrected, and corrected values of 0 and 3 ml $mole^{-1}$ are obtained for the partial molal volume and cavity volume, respectively, of an electron in water. (auth)

33162 CHANGES OF ESR SPECTRUM OF POLY(METHYL METHACRYLATE) DURING DECAY OF FREE RADICALS AT HIGH PRESSURES. Szocs, F. (Inst. of Polymers, Bratislava). Chem. Zvesti; 26: No. 1, 27-30(1972).

Free radical decay at high pressures in electron-irradiated poly(methyl methacrylate) (PMMA) was studied. It was found that by the effect of high pressure the free radical decay is slowed down and, simultaneously, great changes of the line intensity ratio occur in the form of ESR spectrum of free radicals. Changes of the ESR spectrum appearing during free radical decay over the temperature range 100 to 180°C at pressures of 5000 and 10,000 atm respectively, are discussed. (auth)

33163 REACTION OF TRIACETONEAMINE-N-OXYL WITH HYDROXYL RADICALS. Willson, R. L. (Mount Vernon Hospital, Middlesex, Eng.). Int. J. Radiat. Biol.; 21: No. 4, 401-2 (Apr 1972).

A rate constant, k_1, for the reaction of the hydroxyl radical with triacetoneamine-N-oxyl (TAN), was obtained by competition studies carried out with phenylalanine (PA). During pulse radiolysis of N_2O-saturated solutions of phenylalanine (10^{-3}M), the rate of decay of the absorption at 320 nm was unaffected by the presence of TAN (10^{-4}M), and the magnitude of the absorption was over 20 times greater than that observed in solutions of TAN alone. A competition plot obtained by pulse radiolysis of N_2O-saturated solutions of PA for various concentrations of TAN is presented. From the slope of this plot and previous determinations of the rate constant of the reaction of PA with OH radicals, a value of $3.3 \pm 0.3 \times 10^9$ M^{-1} sec^{-1} was derived. (UK)

33164 STUDIES OF LIGHT EMISSION IN THE PULSE RADIOLYSIS OF GASES: ELECTRON-ION RECOMBINATION IN NITROGEN. Sauer, Myran C. Jr.; Mulac, William A. (Argonne National Lab., Ill.). J. Chem. Phys.; 56: No. 10, 4995-5004 (15 May 1972).

An experimental method for studying ion recombination processes using pulse radiolysis is described. The electron-ion recombination coefficient in N_2 (280 to 980 torr) was determined to be $3 \pm 0.6 \times 10^{-6}$ cm^3 $ion^{-1} \cdot sec^{-1}$ at 25°C by analysis of the light emitted by $N_2(C^3\pi_u)$, which is produced in the neutralization reaction. This recombination coefficient obeys a $T^{-1/2}$ dependence. The formation of O_3 from an O_2-SF_6 system was used as a radiation dosimeter to obtain the concentration of ions produced by a pulse of 13 MeV electrons. (auth)

33165 INVESTIGATIONS OF EARLY RADIATION CHEMICAL EFFECTS AND THEIR SIGNIFICANCE IN BIOLOGICAL SYSTEMS. Sangster, D. F. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp 481-96 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Experimental techniques are described which enable early radiation chemical processes to be studied. By means of pulse radiolysis, events at times of the order of 10^{-11} sec can be investigated. Alternatively, organic compounds frozen as glasses at low temperature can be used to trap transient species. A better understanding has been obtained of the formation of excited species and primary charged species and of their reactions. The known behavior is compared with that expected from the consideration of model systems. Evidence for the existence of "dry" electrons or quasi-free electrons is examined. The stabilization of electrons in polar materials is shown to depend on the structure of the medium. Experiments at Lucas Heights using a 3-μsec electron pulse to irradiate mixtures of polar and non-polar compounds indicate that there are polar regions which are capable of solvating electrons. Down to a critical dilution the regions continue to exist almost undisturbed but at greater dilutions they are successively broken up and finally disappear. Pulse radiolysis investigations of chemical systems are described. Using time resolutions of the order of a microsecond many of the reactions of radical species can be followed and absolute rates of reaction can be measured. The unique advantage of pulse radiolysis is that the early chemical reactions can be interpreted free of the complications introduced by subsequent reactions. A two- or three-group treatment of linear energy transfer (LET) effects is shown to be valid for photon irradiation of one chemical system— Fricke dosimeter solution—and to be an improvement on the "average G value" treatment. The concepts associated with the initial physico-chemical events are discussed in terms of the behavior of biological systems exposed to high-energy radiations. (auth)

33166 RADIOLYTIC OXIDATION OF PEPTIDE DERIVATIVES OF GLYCINE IN AQUEOUS SOLUTION. Makada, Hashim A.; Garrison, Warren M. (Univ. of California, Berkeley). Radiat. Res.; 50: No. 1, 48-55(Apr 1972).

A study was made of the γ-induced reactions of the peptide derivatives N-acetylglycine and glycylglycine in oxygenated solution. In these systems the OH radical is removed through reaction at the C–H position of the main-chain $OH + RCONHCH_2R \rightarrow RCONH\dot{C}HR + H_2O$ to yield the corresponding peroxy radical via $O_2 + RCONH\dot{C}HR \rightarrow RCONNCH(\dot{O}_2)R$. The subsequent chemistry was examined in detail. The proposed reaction schemes account for the yields of ammonia, glyoxylic acid, formic acid, and hydrogen peroxide observed in both systems. (auth)

33167 RADIOLYSIS OF ALIPHATIC CARBOXYLIC ACIDS: ON THE DECARBOXYLATION OF NORMAL ACIDS AT 77°K. Jones, A. Russell (Oak Ridge National Lab., Tenn.). Radiat. Res.; 50: No. 1, 41-7(Apr 1972).

The radiolytic decarboxylation of members of the homologous series of normal aliphatic carboxylic acids was studied at –196° in order to investigate the effects of chain length and temperature on the carbon dioxide yields. A comparison with radiolytic data obtained at 38° shows that the solid phase radiolysis of these compounds is temperature dependent. In contrast to the results from the irradiation of the same acids in the liquid state, the yields of carbon dioxide do not vary smoothly from member to member as the homologous series is ascended. Instead, a clearly defined alternation in the yields is evident for the acids above C_{10}, with the odd-numbered acids having larger values of $G(CO_2)$. Formic acid again deviates from the other homologs. The experimental relationship between chain length and decarboxylation yield for the liquid and solid phases is discussed in relation to a simple model. (auth)

33168 EFFECT OF MOLECULAR OXYGEN ON THE FORMATION OF RADICALS IN IRRADIATED POLYMETHYL METHACRYLATE. Fang, P. H. (Boston Coll., Chestnut Hill, Mass.). Radiat. Res.; 50: No. 1, 1-5(Apr 1972).

A mathematical problem that relates the instantaneous oxygen concentration to the formation of radioinduced radicals in poly(methylmethacrylate) was solved. On the basis of this result, first, the validity of an apparent threshold dose for radical formation was proved; second, the interaction constant between oxygen molecules and the radicals was calculated explicitly. (auth)

33169 RADICAL SPECIES OBSERVED IN RADIOLYSIS PRODUCTS OF DURENE. Heurtaux, Jacques (CEN, Grenoble, France). J. Chim. Phys.; 69: No. 2, 315-19(Feb 1972). (In French).

An attempt was made to complete already published results concerning the 13-proton species appearing when durene is irradiated. The investigations were made as a function of the orientation of a normal crystal and a crystal deuterated in positions 1 and 4. The respective contributions of aromatic and aliphatic protons to the ESR spectrum were thus demonstrated. (France)

33170 RADIOCHEMICAL INVESTIGATION OF AQUEOUS POTASSIUM IODIDE SOLUTION. I. Zsarnai, Margit; Kroo, Erik; Laszlo, Botar. Magy. Kem. Foly.; 78: No. 1, 15-18(Jan 1972). (In Hungarian).

The radiolysis of a 10^{-3} M aqueous potassium iodide solution was investigated in 1N H_2SO_4 medium, in the presence of air. Monotonic decrease of the rates of iodide oxidation and hydrogen peroxide formation was observed as a function of the dose absorbed. The initial yields are characterized by the relation $G^0(I_2) + G^0(H_2O_2) = 8$, in good agreement with the value 7.8 calculated on the basis of an eight-step mechanism. The apparent dependence of the yields on the dose intensity can be explained by the occurrence of the thermal reaction $H_2O_2 + I^-$ during irradiation. (auth)

33171 APPLICATION OF THE SEMICONTINUUM MODEL TO THE EFFECT OF DIPOLE REORIENTATION ON TRAPPED ELECTRON SPECTRA IN GLASSY ETHANOL. Fueki, Kenji; Feng, Da Fei; Kevan, Larry (Wayne State Univ., Detroit). J. Chem. Phys.; 56: No. 11, 5351-7(1 Jun 1972).

A semicontinuum model was applied to trapped electrons in glassy ethanol at 77°K. The configurational stability of the ground state was established. Ground, excited, and continuum states are calculated self-consistently for specific orientations from 80 to 0° of the molecular dipoles with respect to the trapped electron. It is shown that spectral shifts observed for trapped electrons in pulse radiolysis experiments on alcohol glasses and the shifts observed on warming from 4 to 77°K after γ irradiation at 4°K can be semiquantitatively accounted for by the molecular dipole orientation mechanism. The cavity radius of the trapped electron also increases somewhat upon dipole orientation but this is a small effect. The effect of dipole orientation upon other physical properties of the trapped electrons in ethanol is also discussed. (auth)

33172 LAPLACE TRANSFORM METHOD IN THE THEORY OF ION NEUTRALIZATION. APPLICATION TO SCAVENGING PROBABILITY IN THE γ RADIOLYSIS OF DIELECTRIC LIQUIDS. Abell, G. C.; Mozumder, A.; Magee, J. L. (Univ. of Notre Dame, Ind.). J. Chem. Phys; 56: No. 11, 5422-7(1 Jun 1972).

A numerical method is presented for solution of the Smoluchowski equation describing the diffusion and reaction of an isolated ion pair in a dielectric medium in the presence of a scavenger. The method provides upper and lower bounds to the exact solution and a practical means for improving these bounds. A quantitative understanding of the neutralization and scavenging processes associated with isolated charge pairs is demonstrated to be possible. This holds for all times and for all scavenger concentrations. Calculations are performed for various initial separations of the ion pair, and the results are compared with the scavenging experiments of Schuler et al. A comparison is also made with the results obtained by the method of "prescribed diffusion." (auth)

33173 VISCOSITY-DEPENDENT RATE OF ION RECOMBINATION FOLLOWING PULSE IRRADIATION. Sawai, Takeshi; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 56: No. 11, 5524-7(1 Jun 1972).

Triphenylamine (TPA) in alkane radiolytic systems traps both electrons and holes. The recombination fluorescence of $TPA^+ - TPA^-$ geminate pairs decays exponentially, and the half-life t_r depends empirically on $(\text{viscosity})^{1/2}$. This dependence applies equally for squalene as solvent over a range of temperature and for isothermal variation of viscosity in mixtures of squalene and 3-methylpentane. The relation $t_r \propto \eta^{1/2}$ is attributed to a Boltzmann dependence of ion jump along field lines with mean free path λ. The mean free path is described in terms of the Cohen and Turnbull free-volume model. The probability of a redistribution of free volume v_f for a critical v^* (and λ^*) is $P(v^*) = \exp(-\gamma v^*/v_f)$, with $\gamma \cong 1$. Defining $\lambda = \lambda^* P(v^*)$ the motion of the correlated ion pair is given by $dR = [1 - \exp(-e^2\lambda/\epsilon R^2 kT)]u dt$, where u is thermal kinetic velocity and 2R is the separation of the ion pair. (auth)

33174 SCAVENGING KINETICS OF ELECTRONS PRODUCED BY IRRADIATION OF ORGANIC GLASSES; EXPERIMENTAL EVIDENCE FOR LONG RANGE TUNNELING. Miller, John R. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 56: No. 10, 5173-83(15 May 1972).

New experimental results are reported on the influence of scavengers on the yields of trapped electrons in γ-irradiated organic glasses, which show that: (1) Trapped electron yields observed minutes after irradiation decrease exponentially with scavenger concentration; (2) transfer of trapped electrons to scavengers continues after irradiation, even in rigid matrices where no trapped electron decay occurs in the absence of scavengers; (3) the presence of a scavenger of low electron affinity can increase the yield of the anion of a scavenger of high electron affinity, although a large decrease would be expected if the scavengers competed for mobile electrons; (4) the "electron capture cross sections" of scavengers are often strongly dependent on what species the scavengers compete with for electrons, apparently indicating that the "electron capture cross section" is not an appropriate concept. These results and several others are consistent with a model involving tunneling of trapped electrons, but seem to be inconsistent with any model based on capture of electrons prior to their localization in traps. (auth)

33175 STUDY OF THE γ-RADIOLYSIS OF AMINO ACIDS AND DIPEPTIDES BY ULTRA-VIOLET REFLECTANCE SPECTROPHOTOMETRY. Kushelevsky, A. P.; Slifkin, M. A. (Univ., of Salford, Eng.). Radiat. Res.; 50: No. 1, 56-64(Apr 1972).

The γ-radiolysis of amino acids and dipeptides gives rise to species that absorb in the ultraviolet in the region of 250 to 400 nm and can be observed by reflectance spectrophotometry. These species cannot be associated with chemical products of radiolysis. Studies on the intensity of the reflectance as a function of absorbed dose give identical curves as for the ESR yields of these substances as a function of absorbed dose. These absorbing species are identified as the free radicals of the amino acids and dipeptides. (auth)

33176 MAGNETIC RESONANCE STUDY OF RADICAL RECOMBINATION IN IRRADIATED CYSTEINE HYDROCHLORIDE

MONOHYDRATE. Ramsbottom, Jeffrey Victor. Waterloo, Ont.; Univ. of Waterloo (1971).

Thesis.

Radical decay in uv and γ-irradiated cysteine HCl monohydrate was studied by EPR as a function of temperature from 340 to 390°K. Proton T_1, $T_{1\rho}$, and absorption for cysteine HCl monohydrate, γ irradiated cysteine HCl monohydrate, and anhydrous cysteine HCl were measured as a function of temperature from 77 to 410°K. A phase change is reported for the polycrystalline monohydrate at 333°K, above which temperature a crystalline (Phase I) and a glassy (Phase II) coexist. This equilibrium is stable with respect to time at a particular temperature, but irreversible with respect to crystallinity. Phase I is shown to be the polycrystalline HCl monohydrate structure, whereas Phase II displayed properties atypical of both liquids and solids. No phase change occurred in the anhydrous cysteine HCl. NMR data are interpreted in terms of molecular reorientation, rotation, and diffusion. For the polycrystalline monohydrate, the correlation frequency and correlation time for NH_3^+ reorientation around the C_3 axis, and for C_2 rotation of H_2O molecules, are calculated. For anhydrous cysteine HCl, correlation frequencies and times for the reorientation of two nonequivalent NH_3^+ groups are calculated. The EPR-observed decay of "sulfur" radicals was second order and shown to occur only in Phase I. Possible mechanisms leading to this decay are discussed. It was proposed that the radical exchange reaction necessary to facilitate the decay of two neighboring neutral sulfur radicals is a hydrogen atom exchange between the -SH group of one molecule and a neighboring sulfur radical. (Diss. Abstr. Int., B)

33177 POLYMERIZATION OF GASEOUS VINYL BROMIDE BY X RAYS. Grossoleil, Jacques; Herman, J. A. (Univ. Laval, Quebec). J. Chim. Phys.; 69: No. 2, 320-3(Feb 1972). (In French).

Gaseous vinyl bromide was polymerized by x rays. The degree of polymerization of the liquid polymer is low, suggesting that short kinetic chains prevail in the system. The termination of the active polymers may be due entirely to primary radicals and deactivating transfer of radiolysis products. Oxygen accelerates the polymerization, nitric oxide diminishes slightly the polymerization rate, and ammonia increases the rate. (France)

33178 ENERGY LEVEL STRUCTURE OF TRAPPED ELECTRONS IN METHYLTETRAHYDROFURAN GLASS FROM PHOTOCONDUCTIVITY AND OPTICAL BLEACHING STUDIES. Huang, Timothy; Eisele, Ignatz; Lin, D. P.; Kevan, Larry (Wayne State Univ., Detroit). Contract AT(11-1)-2086. J. Chem. Phys.; 56: No. 9, 4702-10(1 May 1972).

Electrons are trapped in γ-irradiated methyltetrahydrofuran (MTHF) glass at 77°K. Monochromatic photoexcitation produces photoconductivity and optical bleaching with a threshold near 780 nm (1.6 eV) and a peak near 520 nm (2.4 eV). This transition is linear in light intensity and independent of temperature between 77 and 4.2°K, so it is interpreted as a one-photon transition directly to the conduction band or to an autoionizing state. Effective double beam photoexcitation discloses a two-photon transition that depends on the light intensity squared. The first photon corresponds to the well-known optical absorption of trapped electrons in MTHF at 1.0 eV. This transition is interpreted as a 1s → 2p type. The 2p state then presumably crosses to a 2s-type state from which the second photon is absorbed. The wavelength dependence of the second photon transition shows a peak at 950 nm (1.3 eV) and a threshold near 1150 nm (1.1 eV). The temperature of both optical bleaching and photoconductivity under ir photoexcitation shows that population of the 2s-type state involves an activation energy ~0.001 eV. The deduced energy level structure agrees well with theoretical calculations based on a semicontinuum model for trapped electrons in glassy matrices. Compared to more polar matrices like ice, both experiment and theory indicate that in less polar matrices like MTHF the short-range charge–dipole interactions are relatively less important compared to the long range polarization interactions and cause the bound excited states to be relatively more stable and the ground state to be relatively less stable. (auth)

33179 RADIATION-INDUCED COPOLYMERIZATION OF VINYLPHOSPHONYL DICHLORIDE WITH ACRYLONITRILE. Fujii, Shigetada; Maeda, Katsuaki (Government Industrial Research Inst., Nagoya, Japan). Nippon Kagaku Kaishi; No. 1, 215-17(Jan 1972). (In Japanese).

The γ-induced copolymerization of vinylphosphonyl dichloride (VPDC) with acrylonitrile (AN) was studied at 25 and −78°C, and the reaction mechanism was examined. The copolymerization proceeded by a free radical mechanism at 25°C, and the following reactivity ratios Q_1 and e_1 value for VPDC monomer (M_1) were estimated: $r_1 = 0.05$, $r_2 = 6.0$, $Q_1 = 0.87$, and $e_1 = 2.7$. On the other hand, the rate of copolymerization has a maximum point at about 30 mol % of VPDC monomer concentration at −78°C. In the Fineman–Ross diagram, the r_1 took a negative value, and moreover, the points shifted from the linear relation in the region from 70 to 0 mol % of VPDC monomer concentration. (auth)

33180 RADIATION-INDUCED ADDITION OF ETHYL METHANETRICARBOXYLATE (EMT) TO α-OLEFINES. Saus, A.; Dederichs, B. (Technische Hochschule, Aachen). Tetrahedron Lett.; No. 13, 1291-4(Mar 1972). (In German).

The radioinduced formation of ethyl alkane-1,1,1-tricarboxylates (the 1 : 1 adducts formed from the title compounds) was investigated, using 1-hexene, 1-heptene, 1-octene, 1-undecene, and 1-dodecene as the olefins. The yields and G-values of the adducts at 20°C and for a dose rate of 2.5×10^5 rad/h are tabulated, showing their variation with olefin chain length and molar EMT: olefin ratio. The dose dependence of the G-value for adduct formation was studied; taking 1-dodecene as example, G-values for radiation doses of 0.75, 1.5, and 3.0×10^7 rad were 81, 66, and 77 (average 75), respectively. (UK)

33181 ELECTRON-RADIATION CHEMISTRY OF THE RADICAL SCAVENGER 1,1-DIPHENYL-2-PICRYLHYDRAZYL IN METHYL IODIDE. Kalus, Werner H. (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Z. Naturforsch.; 27b: No. 5, 514-17(May 1972). (In German).

The radical scavenger 1,1-diphenyl-2-picrylhydrazyl (DPPH) in methyl iodide solution was exposed to electrons in the absence of air. The products were separated by thin-layer chromatography. The substances were characterized and identified as 1,1-diphenyl-2-picrylhydrazine, p-nitrodiphenylamine, 2,6-dinitrodiphenylamine, 1-phenyl-1-(p-nitrophenyl)-2-picrylhydrazine, and 2,4,6-trinitroaniline. In addition some unidentified products were formed. Mass- and ir-spectrometric analysis of the low–molecular–weight products indicates that they are produced by the splitting of the N–N-bond in the DPPH molecule. From the material balance and the chemical compositions of the reaction products, it is presumed that the early stage of the decomposition of DPPH induced by electrons is a nitration of DPPH. A mechanism is formulated to explain the formation of the compounds. (auth)

33182 UNSTABLE INTERMEDIATES. PART 108. ELECTRON SPIN RESONANCE STUDY OF RADICALS FORMED BY THE IRRADIATION OF POLYCARBONATE AND MODEL COMPOUNDS. Lyons, A. R.; Symons, M. C. R.; Yandell, J. K. (Univ. of Leicester, Eng.). J. Chem. Soc., Faraday Trans., II; 68: No. 3, 495-501(1972).

ESR spectra from poly[(oxycarbonyloxy-p-phenylene)isopropylidene-(p-phenylene)] γ- or uv irradiated at 77°K showed features characteristic of radical pairs in addition to central features assigned mainly to phenoxy radicals. Their decay on slow annealing was studied and compared with those of similar radicals and radical pairs in γ-irradiated diphenyl carbonate. In the latter the pairs decay rapidly at temperatures far lower than that required for loss of the non-paired radicals. In contrast, paired and non-paired species showed similar decay characteristics in the polymer. Other aspects of radical pair-trapping and decay are reported and discussed. (auth)

33183 CHEMICAL STRUCTURE OF CELLULOSE-STYRENE GRAFT COPOLYMER. Ikada, Yoshito; Nishizaki, Yasuko; Sakurada, Ichiro (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 50: No. 1, 20-6(Jan 1972).

The chemical structure of a cellulose–styrene graft copolymer prepared by a mutual irradiation method was determined. The grafting was carried out by γ irradiation of cellulose fibers immersed in monomer solution. The graft fibers were extracted with benzene to remove homopolystyrene and the apparent graft was then acetylated. To remove ungrafted cellulose in the form of cellulose triacetate from the apparent graft, the acetylated product was dissolved in methylene chloride followed by addition of methanol till all the graft copolymer and the remaining homopolystyrene were precipitated leaving cellulose triacetate in solution. Finally, the homopolystyrene present in the precipitate was extracted. To separate branches from the graft copolymer, it was hydrolyzed. Molecular weights of the graft copolymer and the branch were determined osmometrically. It was found that the apparent and true percent grafts were 44.0% and 11.0%, respectively. Only 4.95% of cellulose participated in the grafting. Each graft copolymer molecule carried one branch on the average. (auth)

33184 DEPOLYMERIZATION OF CELLULOSE BY ELECTRON BEAM IRRADIATION. Imamura, Rikizo (Kyoto Univ.); Ueno, Takeo; Murakami, Koki. Bull. Inst. Chem. Res., Kyoto Univ.; 50: No. 1, 51-63(Jan 1972).

The depolymerization of cellulose by means of a high-energy irradiation was studied using ^{60}Co gamma ray or an electron beam as an irradiation source. It was found that the number of broken bonds, calculated from the average degree of polymerization (P_n) of irradiated samples, is linearly proportional to the absorbed doses, and an experimental equation applicable to both types of irradiation was established. By use of this equation, the relative absorbed dose distribution within the pulp sheets in the pile irradiated with electron beams was determined from the P_n values for each sheet. Furthermore, in order to make the absorbed dose distribution narrower, the utilization of electron filters as well as back-scattering bodies was studied with an electron beam at 2 and 0.5 MeV, respectively. Although both techniques are useful to prevent the samples from causing wide absorbed dose distribution, it may be noted that higher irradiation efficiency (95% or more) and narrower absorbed dose distribution are achieved using a single side irradiation method of the latter. The various samples thus irradiated were nitrated and characterized successfully for molecular weight distributions using gel permeation chromatography. (auth)

Radiochemistry and Nuclear Chemistry

33185 (BMBW-FBK–71-17) PROCEEDINGS OF THE THIRD INTERNATIONAL PROTACTINIUM CONFERENCE, SCHLOSS ELMAU, GERMANY, 15–18 APRIL 1969. Born, H.-J. (ed.) (Technische Universitaet, Munich (West Germany). Institut fuer Radiochemie). Oct 1971. 455p. (In several languages). (CONF-690460). ZAED DM 95.50.

Thirty-seven articles are included; an abstract was prepared for each article. An abstract only is given for an additional paper on reactor neutron induced fission of ^{233}Pa by means of physical methods using a Ge(Li) detector. (P.C.H.)

For abstracts of individual papers see: 33061, 33081, 33107–33111, 33186, 33192–33209, 33236, 33237, 33835, 33836, 33914, 33915, and 34955–34959.

33186 (BMBW-FBK–71-17, pp 0.14-19) DISCOVERY AND NAMING OF THE ISOTOPES OF THE ELEMENT 91. Fajans, Kasimir (Michigan Univ., Ann Arbor). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The history of the discovery of the three naturally occurring isotopes of element 91 is presented, and a complete list of the now known isotopes of protactinium is given. It was found that the enormous range of stability can be related with the masses of these isotopes and with the kind of radioactive transformation their nuclei undergo. (D.H.M.)

Hot-Atom Chemistry

33187 RECOIL TRITIUM REACTIONS WITH ORGANOSILICON COMPOUNDS. Daniel III, Samuel Henderson. College Station, Tex.; Texas A and M Univ. (1971). 175p. University Microfilms Order No. 72-13,212.

Thesis.

A detailed examination of recoil tritium reactions with organosilicon compounds was made in order to determine what part chemical factors played in controlling hot reaction product yields. Bond strength and electron density were shown to be definite factors in determining the yield of products. Also, the formation of some type of complex between silicon's 3d-orbitals and a tritium atom was considered in order to explain the exceptionally high reactivity of the Si–Si bond of hexamethyldisilane. The organosilicon compounds used were dimethylsilane, trimethylsilane, tetramethylsilane, trimethylfluorosilane, dimethyldifluorosilane, methyltrifluorosilane, and hexamethyldisilane. Reactions of recoil tritium with dimethylsilane, trimethylsilane, and tetramethylsilane were carried out in pure single component systems and in two component competition systems with their corresponding member in the alkane family. It was determined that dimethysilane and trimethylsilane are respectively about 50 and 20% more reactive than their hydrocarbon counterparts; while the total reactivity of tetramethylsilane is approximately the same as that for neopentane. (TSS) (Diss. Abstr. Int., B)

33188 RECOIL TRITIUM REACTIONS WITH HEXAMETHYLDISILANE IN THE GAS PHASE. Daniel, S. H.; Gennaro, G. P.; Ranck, K. M.; Tang, Y.-N. (Texas A and M Univ., College Station). Contract AT(40-1)-3898. J. Phys. Chem.; 76: No. 9, 1249-54(27 Apr 1972).

A series of recoil tritium experiments is described with hexamethyldisilane in which hydrogen abstraction and substitution, heavy group displacement, and reaction at the Si–Si bond are observed. Effects of additives, total system pressure, and radiolysis were evaluated. Reactivities on a "per bond" basis were determined for each bond in hexamethyldisilane relative to those in neopentane. The relative order was found to be: Si–Si > C–H > C–Si > C–C. In fact, the Si–Si bond was estimated to be the most reactive single bond toward high-energy tritium yet encountered. This high reactivity is thought, on the basis of O_2 and C_2H_4 additive effects, to be due to both a low threshold energy and a high reaction cross section. Results are interpreted in terms of possible chemical effects on these high-energy reactions, such as a low bond dissociation energy. (auth)

33189 PRODUCTION OF TRIPLET METHYLENE IN THE REACTION OF CARBON ATOMS WITH HYDROGEN. Rose, Timothy L. (Texas A and M Univ., College Station). J. Phys. Chem.; 76: No. 10, 1389-91(11 May 1972).

The reactions of free carbon atoms in hydrogen–cyclopentadiene samples were studied using the nuclear recoil technique. A comparison of these hot-atom results with photochemical methylene studies shows that the carbon atoms react with hydrogen to produce methylene which is almost entirely in the triplet state. (auth)

Properties of Radioactive Materials

Refer also to abstracts 33050, 33053, 33061, 33842, and 33914.

33190 (ANL–7876) CHEMICAL ENGINEERING DIVISION, THERMOCHEMICAL STUDIES SEMIANNUAL REPORT, JULY–DECEMBER 1971. Hubbard, W. N.; O'Hare, P. A. G.; Johnson, G. K.; Ader, M.; Settle, J. L.; Larson, J. W.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 33p. Dep. NTIS.

Standard enthalpies of formation were determined as follows: by solution calorimetry, $\Delta H_f^\circ(Na_3UO_4, c, 298°K) = -477.7 \pm 0.9$, $\Delta H_f^\circ(BrO_3F, l, 298°K) = +26.78 \pm 0.25$, and $\Delta H_f^\circ(ThS_{1.030}, c, 298°K) \cong -97.1$ kcal mol^{-1}; by reaction with PF_3 gas, $\Delta H_f^\circ(XeF_4, c, 298°K) = -63.84 \pm 0.21$ and $\Delta H_f^\circ(XeF_2, c, 298°K) = -38.90 \pm 0.21$ kcal mol^{-1}; and by combustion in fluorine, $\Delta H_f^\circ(N \equiv SF, g, 298°K) \cong 5.2 \pm 0.9$ kcal mol^{-1}. Quantum chemical investigations have continued with calculations on the N–O system. (auth)

33191 (ANL–7877) CHEMICAL ENGINEERING DIVISION FUELS AND MATERIALS CHEMISTRY SEMIANNUAL REPORT, JULY–DECEMBER 1971. Blackburn, P. E.; Johnson, C. E.; Johnson, I.; Martin, A. E.; Tetenbaum, M.; Crouthamel, C. E.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Apr 1972. Contract W-31-109-eng-38. 47p. Dep. NTIS.

To aid in evaluating the performance of fast-breeder-reactor fuels, high-temperature investigations are being made of the U–Pu–Na–O, U–Pu–Cs–O, U–Mo–O, and U–Pu–Ce–O systems. Mass-spectrometric phase and reaction studies of the U–Na–O and U–Pu–Na–O systems are directed toward determining conditions for preventing or controlling a reaction between oxide fuels and sodium coolant. The interaction of fission product cesium with UO_2-PuO_2 fuel under reactor operational conditions is being investigated to determine the effect on cladding attack and fuel swelling. Relative ion cross sections of U and U–O gases were measured to establish accurate partial pressures over the fuel from mass-spectrometric data. These pressures are used to calculate fuel oxygen potentials at high temperatures, and they will also be used to compute vapor-transport redistribution of U, Pu, and O in the fuel. Activity measurements in the U–Ce–O system by a gas equilibration and transpiration technique were initiated to determine the effects of burnup on oxygen potentials in the fuel. New techniques are being implemented to aid in analysis of irradiated fuel; these include ion microprobe mass analysis and computerized electron microprobe analysis. Studies of irradiated fuel samples were directed toward examination of the behavior of fission-product molybdenum in several UO_2–20 wt % PuO_2 fuels. Electron microprobe analysis showed that molybdenum is present in metal inclusions as well as in the oxide matrix. A method is proposed for estimating the oxidizing potential of the fuel using $Mo-MoO_2$ as a "redox-indicator" system. Studies of fuel-cladding interactions are continuing in an effort to elucidate the mechanism of intergranular attack of the cladding. (auth)

33192 (BMBW-FBK–71-17, pp 8,1-11) SOLID STATE CHEMISTRY OF PROTACTINIUM. Keller, Cornelius (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The preparation and structural properties of protactinium oxides and halides are described. Ternary oxides and oxide phases of different composition and structure may be prepared by reaction of protactinium oxides with the oxides of other elements. Two types of reactions are discussed in detail: the reaction between Pa_2O_5 and Li_2O representing the protactinium pentoxide–alkali metal oxide system; and the reaction between Pa_2O_5 and Ho_2O_3, which may be considered as representative for the non-stoichiometric oxide phases that are obtained by the reaction between Pa_2O_5 and the oxides of ter- and tetravalent lanthanide and actinide elements. Data on structure are tabulated, and fluorocomplexes are discussed. (P.C.H.)

33193 (BMBW-FBK–71-17, pp 9.1-6) PROTACTINIUM(V)-AND NEPTUNIUM(V)-OXYFLUORIDES. Bagnall, K. W.; Brown, D.; Easy, J. F. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The reaction between vacuum-dried protactinium(V) hydrous oxide and anhydrous hydrogen fluoride yields $PaF_5{\cdot}2\ H_2O$ at 40°C, $PaF_5{\cdot}H_2O$ at 60°C, Pa_2OF_8 at 140°C, and Pa_2F_9 at 500°C. The new protactinium(V) oxyfluoride, PaO_2F, is obtained when $PaF_5{\cdot}2\ h_2O$, $PaF_5{\cdot}H_2O$, or Pa_2OF_8 is heated in air at 270°C. Above 400°C this decomposes to another, as yet unidentified, oxyfluoride which in turn decomposes to Pa_2O_5 above 600°C. Other reactions involving fluorination or hydrofluorination of various protactinium(IV) and (V) oxyhalides are discussed. In contrast to these reactions, neptunium pentoxide reacts with anhydrous hydrogen fluoride at 40 to 60°C to yield $NpOF_3{\cdot} \times H_2O$ (1 × 2). At 100 to 150°C $NpOF_3$ is formed. Another new neptunium(V) oxyfluoride, NpO_2F, is obtained from the reaction between NpO_2F_2 and hydrogen at 325°C. NpO_2F is not isostructural with PaO_2F but the product from the analogous reaction involving UO_2F_2 and hydrogen at 360°C does have a similar x-ray powder diffraction pattern to that of PaO_2F. Some chemical properties and infrared results are reported for these compounds. (auth)

33194 (BMBW-FBK–71-17, pp 11.1-6) STUDIES ON PHOSPHATES OF PENTAVALENT PROTACTINIUM. Le Colarec, M. F.; Muxart, R. (Paris Univ., Arcueil (France). Institut de Physique Nucleaire). Oct 1971. (In French).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Studies were made on the composition of the salt that is precipitated by the action of phosphoric acid on a sulfuric acid solution of Pa(V). The dense white precipitate was dried, the Pa and PO_4^{3-} anion were separated by chromatography, then determined by radiometric and colorimetric methods. Results indicate that the precipitated compound is amorphous and consists of an anion of PO_4^{3-} per atom of Pa. Absorption ir spectral frequencies are tabulated. (J.G.B.)

33195 (BMBW-FBK–71-17, pp 12.1-7) STUDIES OF IODATES OF PROTACTINIUM(V). Muxart, R.; Vernois, J.; Arapaki-Strapelias, H. (Paris Univ., Arcueil (France). Institut de Physique Nucleaire). Oct 1971. (In French).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The composition of compounds precipitated by the addition of sodium iodate to a 5 to 6N H_2SO_4 solution of Pa was studied. After calcination of the compounds at 1050 to 1100°C, protactinium was determined by radiometric methods. The iodate anion was determined using iodometric methods. Results indicate that the ratio $I_2O_5 : Pa_2O_5$ varies from 0.75 to 2. Whatever may be the value of this ratio, the Pa(V) compounds present themselves as a fine, white powder insoluble in 6M HNO_3, 5 to 6N H_2SO_4, ethanol, and acetone, but highly soluble in dilute HF. They are hydrolyzed by water and oxidize an aqueous solution of KI. They decompose slowly at atmospheric pressure at 2°C, liberating iodine. Thermal decomposition of a sample in which the ratio $I_2O_5 : Pa_2O_5 = 0.82$ was studied by thermogravimetric methods and differential thermal analysis. Absorption spectra of samples with ratio $\cong 2$ are tabulated. (J.G.B.)

33196 (BMBW-FBK–71-17, pp 13.1-13) HEATS OF SOLUTION OF SOME HALIDES AND OXYHALIDES OF TETRAVALENT PROTACTINIUM. Fuger, J. (Liege Univ. (Belgium)); Brown, D. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Heats of solution in aqueous hydrochloric acid of the chloride, bromide, and iodide of tetravalent protactinium were determined. These results are compared with those obtained for the tetrahalides of other actinides. Preliminary results on the solution of the oxydichloride and oxydibromide of protactinium are also reported. (auth)

33197 (BMBW-FBK–71-17, pp 18.1-12) VAPOR PRESSURE OF PROTACTINIUM(V) CHLORIDES. Weigel, F.; Hoffmann, G.; Ter Meer, N. (Munich Univ. (West Germany)). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The vapor pressure of anhydrous protactinium(V) chloride was measured by means of a pyrex sickle gage in the temperature range 500 to 600°K. The temperature dependence of the vapor pressure of molten $PaCl_5$ may be described by the equation: In p (mm Hg) = 17.27 − 7377/T (1) for the temperature dependence of the vapor pressure of solid $PaCl_5$, the equation In p (mm Hg) = 23.87 − 11162/T (2) was obtained. Extrapolation of eq. (1) to 760 mm Hg yielded a value of 693°K (= 420°C) for the boiling point of $PaCl_5$. From the vapor pressure data, the following thermodynamic parameters were calculated: Entropy of vaporization ΔS_v = 21, 1 e.u., heat of vaporization ΔH_v = 14, 65 kcal/mole, entropy of sublimation ΔS_s = 34, 2 e.u., and heat of sublimation ΔH_s = 22, 17 kcal/mole. The Gibbs energy at the melting point was calculated to be ΔG_m = 2, 4 kcal/mole. (auth)

33198 (BMBW-FBK–71-17, pp 19.1-7) CUBIC COORDINATION: THE CRYSTAL STRUCTURE OF SODIUM OCTAFLUOROPROTACTINATE(V). Brown, D.; Easey, J. F.; Rickard, C. E. F. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The structure of sodium octafluoroprotactinate(V), Na_3PaF_8, was determined by x-ray diffraction methods and refined by full matrix least squares. Crystals of this compound possess tetragonal symmetry, space group $I_4/mmm\text{-}D_{4h}^{17}$, with a_0 = 5.493 Å and c_0 = 10.970 Å. The unit cell contains two molecules. Each protactinium atom is bonded to eight fluorine atoms which lie at the corners of an almost perfect cube. The Pa–F bond distance is 2.21 Å. The sodium atoms are located between the PaF_8^{3-} cubes. Metal–fluorine and fluorine–fluorine distances were calculated for the isostructural uranium and neptunium compounds, Na_3UF_8 and Na_3NpF_8, respectively. (auth)

33199 (BMBW-FBK–71-17, pp 20.1-9) COORDINATION CHEMISTRY OF PROTACTINIUM. Bagnall, K. W. (Manchester Univ. (England)). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The coordination chemistry of protactinium is compared with that of other actinides, niobium, and tantalum, particularly with respect to the halides and their complexes. (D.H.M.)

33200 (BMBW-FBK–71-17, pp 21.1-6) PROTACTINIUM CHELATE CHEMISTRY. Brown, D.; Rickard, C. E. F. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Protactinium(V) halogenotropolonates of the type PaT_4X (T = tropolone, X = Cl, Br, and I) were prepared by reactions in non-aqueous solvents. PaT_4Cl reacts with dimethyl sulfoxide to form $PaT_4 \cdot Cl \cdot$ DMSO and with an excess of lithium tropolonate in ethanol to yield $PaT_4 \cdot$ OEt, which is converted to PaT_4Cl on reaction with 6M hydrochloric acid in acetone. The tetravalent tropolonates PaT_4, NpT_4, and $LiPaT_5$ were prepared but attempts to obtain $LiNpT_5$ were unsuccessful. Diethyldithiocarbamates of protactinium(V), $Pa(dtc)_4Cl$ and $Pa(dtc)_4Br$, are obtained by reactions between Nadtc and the appropriate pentahalide in methylene dichloride. Under similar, oxygen-free conditions oxidation of protactinium(IV) was observed. The chloroacetylacetonate, $Pa(acac)_2Cl_3$, was prepared by direct reaction between acetylacetone and protactinium pentachloride at room temperature. Some chemical properties, infrared spectral studies, and crystallographic results are reported for these compounds. (auth)

33201 (BMBW-FBK–71-17, pp 22.1-7) PHOSPHINE OXIDE, PHOSPHINE SULPHIDE, AND PHOSPHINE SELENIDE COMPLEXES OF PROTACTINIUM, NIOBIUM, TANTALUM, AND URANIUM. Brown, D.; Hill, J.; Rickard, C. E. F. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Protactinium, uranium, niobium, and tantalum complexes of the type $MX_5 \cdot L$ (X = Cl and Br, L = variously Ph_3PO, Ph_3PS, and Ph_3PSe) are obtained by reactions in non-aqueous solvents. Protactinium forms, in addition, complexes of the type $PaX_5 \cdot 2TPPO$ and $PaOX_3 \cdot 2TPPO$ (X = Cl and Br). Niobium and tantalum pentabromides, but not the pentachlorides, form similar 1 : 1 complexes with $Ph_2PSCH_2PSPh_2$, $Ph_2PSCH_2CH_2PSPh_2$, and $Ph_2PSeCH_2PSePh_2$.

However, the formation of 1 : 2 complexes with Ph_3PS and Ph_3PSe is not observed. Infrared spectra and some chemical properties are discussed. (auth)

33202 (BMBW-FBK–71-17, pp 23.1-14) PHTHALOCYANINE COMPLEXES OF THORIUM, PROTACTINIUM, URANIUM, AND NEPTUNIUM. Lux, F.; Brown, D. (Atomic Energy Research Establishment, Harwell (England)); Dempf, D.; Fischer, R. D. (Technische Hochschule, Munich (West Germany)); Hagenberg, W. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

$PaPc_2$ was obtained by reacting protactinium tetraiodide with phthalocyanine. Like the thorium and uranium compounds, $PaPc_2$ was completely stable in air in contrast to other protactinium(IV) compounds that are highly sensitive to oxygen and humidity. Electron spectra, infrared spectra, and electron spin resonance spectra of the phthalocyaninato-actinide complexes were studied. It was concluded that, because of their great stability, the complexes are excellently suited for separation of actinides from fission products. (H.B.G.)

33203 (BMBW-FBK–71-17, pp 24.1-6) AROMATIC COMPLEX OF PROTACTINIUM. Kanellakopulos, Basil (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

At a temperature of about 600°C, protactinium oxide (Pa_2O_5) was chlorinated in a Cl_2-CCl_4-Ar mixture. Within 3 hours, 100 mg of Pa were completely chlorinated. Immediately following chlorination, the protactinium chloride was reacted with molten dicyclopentadienyl beryllium. After 46 hours, excess $Be(C_5H_5)_2$ was removed by vacuum sublimation and the residue was extracted with benzene. The extract yielded an orange-yellow crystalline substance that proved to be pure $Pa(C_5H_5)_4$. The compound was studied by: elemental analysis; absorption spectroscopy in infrared, visible, and ultraviolet ranges; mass spectroscopy; and magnetic resonance. (H.B.G.)

33204 (BMBW-FBK–71-17, pp 25.1-7) STRUCTURAL STUDIES ON ACTINIDE COMPOUNDS. Brown, D.; Easey, J. F.; Holah, D. G.; Rickard, C. E. F. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The structures of the tetrakis (N,N-diethyldithiocarbamate) complexes, $Th(dtc)_4$ and $NEt_4Np(dtc)_4$, were investigated. In both cases there are eight sulfur atoms, arranged as a distorted dodecahedron, coordinated to the metal atoms. Preliminary details are also presented for the protactinium acetylacetone complex, $Pa(acac)_2Cl_3$. The structure of PaI_5 has also been investigated and a probable structure is postulated. (auth)

33205 (BMBW-FBK–71-17, pp 26.1-14) CHEMISTRY OF SOLUTIONS OF PROTACTINIUM. Bouissieres, G. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Oct 1971. (In French).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The chemistry of protactinium solutions is discussed under the headings: hydrolysis, complex formation, other aspects of solution chemistry, and comparison with other elements. Diagrams are given showing the hydrolytic behavior of Pa(V) in perchloric acid solutions, demonstrating colloid formation and variations in properties with time. Complexation of Pa(IV) and Pa(V) is reviewed. Diagrams show the degree of complexation of Pa(V) in citric acid and Pa(IV) in H_2SO_4. Hydrolytic behavior of Pa(IV) is compared with that of Th^{4+}, U^{4+}, Np^{4+}, Pu^{4+}, Hf^{4+}, and Zr^{4+}. Hydrolytic behavior of Pu(IV) is compared with that of U(V), Np(V), and Pu(V). A diagram is included giving percentages of extraction of Pa(V), Nb(V), and Ta(V) from HF media using TBP. (E.J.H.)

33206 (BMBW-FBK–71-17, pp 27.1-11) MECHANISM OF PROTACTINIUM SORPTION BY SILICA GEL. Spitsyn, Vict. I.; Dyachkova, R. A.; Kamenskaya, A. N. (Akademiya Nauk SSSR, Moscow. Institut Fizicheskoi Khimii). Oct 1971.

From third international protactinium conference, Schloss Elmau, Germany (15 Apr 1969).

Regularities observed in protactinium sorption from nitric and perchloric acid solutions by silica gel, cationite KU-2, anionite AV-17, and experiments with electromigration of protactinium have led to the conclusion that the whole range of acidity from 0.01 to 10 M is characterized by ion-exchange sorption of cationic forms of the element with hydrogen ions displaced into the solution and a strong bond formed between protactinium and the oxygen of silanol groups. Over the $[H^+] > 2$ M range the nitric acid solutions display a concurrent sorption of neutral complexes of the element. The kinetics of protactinium sorption by silica gel is of an intradiffusive character over the total acidity range under investigation. The rate of equilibration of sorption depends on the concentration of hydrogen ions passing through the minimum in the range of $[H^+] = 0.5$ to 2 M. (auth)

33207 (BMBW-FBK–71-17, pp 28.1-24) SYNERGISTIC EFFECT OF DI-ISOBUTYL CARBINOL ON THE SOLVENT EXTRACTION SYSTEM Pa(V)-TTA-BENZENE. Suzuki, Shin; Inoue, Yasushi (Tohoku Univ., Sendai (Japan). Research Inst. for Iron, Steel and Other Metals). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The effect of diisobutylcarbinol (DIBC) on the extraction of protactinium from perchloric acid solution by TTA–benzene was studied with the results that a marked synergism was observed. The effects of TTA concentration, DIBC concentration, and acidity were studied and some hypothesis concerning the reasons for irreversible change of the protactinium species in TTA–benzene solution are presented. (D.H.M.)

33208 (BMBW-FBK–71-17, pp 30.1-12) RATE OF OXIDATION OF TETRAVALENT PROTACTINIUM IN HYDROCHLORIC AND PERCHLORIC ACID MEDIA. Genet, M. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Oct 1971. (In French).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The ratio of the percent of $^{233}Pa(IV)$ at time "t" to that at t = 0 was plotted against time at various concentrations of HCl for aerated and nonaerated solutions. Very little difference was noted. The time for the half reaction time for the oxidation is also plotted as a function of the concentration of HCl. Similar graphs are also given for studies with perchloric acid. Considerable variation with hydrogen ion concentration is demonstrated. A study of the kinetics of oxidation of tetravalent Pa in a mixture of HCl and $HClO_4$ shows that at constant acidity the speed of oxidation diminishes with an increase in the concentration of chloride ions. (E.J.H.)

33209 (BMBW-FBK–71-17, pp 31.1-7) EVIDENCE FOR THE EXISTENCE OF A PROTACTINATE ION. Guillaumont, R. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). Oct 1971. (In French).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

An attempt was made to confirm the previously reported existence of the protactinate ion. Identification of a hydroxyl anion of Pa(V) in basic media was attempted through studies on the distribution of $^{233}Pa(V)$ between an aqueous media and benzene solutions of dibenzoylmethane. Results point to the existence of protactinate ions in extremely dilute alkaline solutions. The ion $Pa(OH)_6^-$ appears at pH 9. (J.G.B.)

33210 (CNEA–307) PREPARATION OF URANYL STEARATE. Suner, A.; Botbol, J.; Rodriguez, E. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1972. 11p. (In Spanish). Dep. NTIS (U. S. Sales Only).

A technique for the preparation of uranyl stearate is described. It was established by a potentiometric and analytical study of hydro-alcoholic solutions of stearic acid and uranyl nitrate. Analysis of the neutralization curves showed that uranyl stearate can be prepared by pouring a solution of sodium hydroxide over a hydro-alcoholic solution of stearic acid and uranyl nitrate. The pH of the solution must be maintained between 2.9 and 3.0. The influence of the pH of precipitation on the composition of the precipitation on the composition of the precipitate was studied. (auth)

33211 (DP–981) PRECIPITATION OF PLUTONIUM(III) OXALATE AND CALCINATION TO PLUTONIUM DIOXIDE. Porter, John A.; Symonds, Albert E. Jr. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Nov 1965. Contract AT(07-2)-1. 20p. Dep. NTIS.

Declassified 28 Oct 1971.

Procedures were developed for precipitation of plutonium(III) oxalate from nitric acid, hydrochloric acid, and sulfamic acid solutions. The plutonium was adjusted to Pu(III) with ascorbic acid in the presence of an oxidation inhibitor. Plutonium dioxide was produced by calcining the oxalate in air at temperatures between 450 and 750°C. (auth)

33212 (HW–72244) DISSOLUTION OF PLUTONIUM METAL IN HYDROFLUORIC–NITRIC ACIDS. Kingsley, R. S. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 15 Mar 1962. Contract AT(45-1)-1350. 27p. Dep. NTIS.

Declassified 2 Nov 1971.

Integral dissolution rates for plutonium metal were studied in acid concentrations of 0.01 to 0.5 M HF and 10M HNO_3. Plutonium concentrations varied from 0 to 140 g/l Pu. Integral dissolution rates for turnings determined on a one-liter scale ranged from 1.1 g/min in 0.05 M HF to 6.3 g/min in 0.5 M HF. Integral rates were also determined for mossy metal and BB's. Hydrogen concentrations of 0.2 mol percent were found in the off-gas. Penetration rates for plutonium metal were determined over the range of acid concentrations of 0.7 to 15.8 M HNO_3 and 0.01 to 2 M HF. Plutonium concentrations varied from 0 to 190 g/l Pu. Initial penetration rates at a constant hydrofluoric acid concentration showed a strong dependence on nitric acid concentration. Penetration rates in 0.5 M HF varied from 5 mg/min/cm^2 in 0.1 M HNO_3 to 150 mg/min/cm^2 in 6 M HNO_3. Penetration rates in plutonium product solution of 80 g/l Pu were considerably lower than the initial rates. Little variation of penetration rate with plutonium concentration was found in the range 80 to 190 g/l Pu. Rates in 80 g/l Pu, 10 M HNO_3 varied from 0.2 mg/min/cm^2 in 0.02 M HF to 6 mg/min/cm^2 in 0.5 M HF. An operating range for fluoride was defined by specifying that the Pu/F mol ratio lies between 0.6 and 9. Below 0.6, PuF_4 precipitates, and above 9, PuO_2 precipitates. A postulated mechanism for metal dissolution is that fluoride dissolves the passivating oxide film from the surface of the metal and the nitric acid then dissolves the metal according to the equation. $Pu + 6HNO_3 \rightarrow Pu(NO_3)_4 + NO + NO_2 + 3H_2O$. It was found in the turnings dissolution that 5.7 mols of HNO_3 were required per mol of Pu dissolved. Analysis of the dissolver product on the DK-2 recording spectrophotometer showed 100% $Pu(NO_3)_4$. (auth)

33213 (INR-P-1358) SOME EXPERIMENTS ON THE PRODUCTION OF METALLIC URANIUM FROM $CaUF_6$. Rafalski, Wadim (Institute of Nuclear Research, Warsaw (Poland)). 1971. 11p. (CONF-700540-7). Dep. NTIS (U. S. Sales Only).

From Polish-Italian seminar on some chemical, ceramic and metallurgical aspects of nuclear fuels; Zakopane, Poland (29 May 1970).

Heat balances for the reactions of $CaUF_6$ and UF_4 with Mg were calculated. The temperature where the reaction $CaUF_6$ + Mg starts was determined. Uranium processing, in the scale of 1.5 kg uranium per charge, was performed. The reduction with magnesium of nonstoichiometric $CaUF_6$ was investigated. (auth)

33214 (UCRL-Trans-10596) MOLECULAR PHYSICAL PROPERTIES OF THE HYDROGEN ISOTOPES AND OF THEIR ISOTOPIC COMBINATIONS. Guizouarn, Louis. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from report CEA-Bib-87. 59p. Dep. NTIS.

Experimental results obtained in the past 30 years on the physical properties of the isotopes of hydrogen (deuterium, tritium, and their isotopic combinations with each other and with hydrogen) in the liquid, solid, and gaseous states are presented. An abstract of the original French report appeared as NSA 21: 32138. (M.C.G.)

33215 SELF-DECOMPOSITION OF RADIOACTIVELY LABELLED COMPOUNDS. Sheppard, G. (Radiochemical Centre, Amersham, Eng.). At. Energy Rev.; 10: No. 1, 3-66(Mar 1972).

Radiation self-decomposition has become recognized as a major problem in the use of radioactively labeled compounds. The underlying causes and mechanisms of self-decomposition, which are very complex and in some cases not well understood, are reviewed. However, the amount of information on the behavior of radioactively labeled compounds is rapidly increasing and extensive data on the self-decomposition of nucleotides, carbohydrates, amino acids, steroids, and other important organic compounds are included. The effects of temperature, solvents, concentration, specific activity, and additives are discussed. It is possible to predict those compounds that are notably unstable and suggest methods for stabilizing them. The difficulties in the measurement of the extent of radiochemical decomposition are assessed and the effects of such decomposition on the use of radioactively labeled compounds in biochemical research and as radiopharmaceuticals are pointed out. Special reference is made to the need for the accurate determination of "blanks". (auth)

33216 CHEMISTRY OF URANIUM. III. A NEW METHOD FOR PREPARING URANIUM TETRAIODIDE COMPLEXES. Du Preez, J. G. H.; Gibson, M. L. (Univ. of Port Elizabeth, South Africa). J. Inorg. Nucl. Chem.; 34: No. 5, 1771(May 1972).

During a study of lactam complexes of uranium tetrahalides the metal was reacted in a nitrogen atmosphere, with the stoichiometric amount of iodine dissolved in methyl cyanide at room temperature. After 8 hr a dark brown solution was obtained and a small amount of solid remained. After filtration, addition of ϵ-caprolactam, and crystallization, both analysis and the electronic spectrum showed there to be a uranium(IV) compound present. The preparation of the thorium tetraiodide complex was attempted by a similar procedure. Some thorium went into solution but it was not possible to obtain a pure thorium tetraiodide complex. A yellow product was obtained which contained free iodine, most probably as triiodide in the complex. (UK)

33217 OXIDATION OF URANIUM(IV) BY CHROMIUM(VI) AND THE INDUCED OXIDATION OF IODIDE IONS. Espenson, James H.; Wang, Robert T. (Ames Lab., Iowa). Inorg. Chem.; 11: No. 5, 955-9(May 1972).

The oxidation of U(IV) by Cr(VI) proceeds quantitatively to UO_2^{2+} and $Cr(H_2O)_6^{3+}$. A stopped-flow kinetic study was carried out; after allowance for acid dissociation reactions, the rate equation is $-d[Cr(VI)]/dt = \{k' + k[H^+]^{-1}\}[U^{4+}] \cdot [HCrO_4^-]$, where the acid-independent term, which is quite small, probably represents a medium effect. The reaction produces Cr(V) as an intermediate, as evidenced by the induced oxidation of iodide ions. The iodine yield was evaluated as a function of $[I^-]/[U^{4+}]$ and $[H^+]$ and indicates U(V) is not an intermediate, which is also supported by the effect of Fe^{3+} as well as by ^{18}O studies in the literature. Some experiments on the reactions of U(III) and U(V) with Cr(VI) are also reported. (auth)

33218 TWO ISOSTRUCTURAL ACTINIDE π COMPLEXES. THE CRYSTAL AND MOLECULAR STRUCTURE OF BIS(CYCLOOCTATETRAENYL)URANIUM(VI), $U(C_8H_8)_2$, AND BIS(CYCLOOCTATETRAENYL)THORIUM(IV), $Th(C_8H_8)_2$. Avdeef, Alex; Raymond, Kenneth N.; Hodgson, Keith O.; Zalkin, Allan (Univ. of California, Berkeley). Inorg. Chem.; 11: No. 5, 1083-8(May 1972).

Crystal and molecular structures of the two isostructural cyclooctatetraene dianion π complexes "uranocene" and "thorocene," $U(C_8H_8)_2$ and $Th(C_8H_8)_2$, were determined from three-dimensional x-ray diffraction data. The molecules both have D_{8h} molecular symmetry. The heavy atom in each case is symmetrically π bonded to two aromatic cyclooctatetraene dianion rings related by a crystallographic inversion center. The mean uranium–carbon bond length is 2.647 (4) Å and the mean Th–C bond length is 2.710 (4) Å. The cyclooctatetraene dianion rings are planar with average C–C bond lengths of 1.392 (13) and 1.386 (9) Å for $U(C_8H_8)_2$ and $Th(C_8H_8)_2$, respectively. Differences in the metal–carbon bond lengths in $U(C_8H_8)_2$ and $Th(C_8H_8)_2$ can be calculated from the corresponding change in ionic radii. Deep green plates of $U(C_8H_8)_2$ have the following crystal data: monoclinic space group $P2_1/n$, cell constants a = 7.084 (3), b = 8.710 (3), c = 10.631 (5) Å, and β = 98.75 (3)°. For two formula units in the cell, the calculated density is 2.29 g/cm^3. Bright yellow plates of $Th(C_8H_8)_2$ have the same crystal structure with cell constants a = 7.0581 (11), b = 8.8192 (17), c = 10.7042 (18) Å and β = 98.44 (3)°. The calculated density is 2.2 g/cm^3. Both structures have been refined using full-matrix least-squares methods to unweighted R factors of 2.09 and 2.07% of $U(C_8H_8)_2$ and $Th(C_8H_8)_2$, respectively. (auth)

33219 ASSOCIATION OF CHROMIUM(VI) WITH NEPTUNIUM(IV) AND THORIUM(IV) IN PERCHLORATE SOLUTION. Burkhart, Mary Jane; Thompson, Richard C. (Univ. of Missouri, Columbia). J. Amer. Chem. Soc.; 94: No. 9, 2999-3002(3 May 1972).

The association of chromium(VI) with the cations Np(IV), Th(IV), and Fe(III) in perchlorate solution was studied by a spectrophotometric procedure. Values of the formation constant $K_{eq} = (M-CrO_4)^{n-2}(H^+)/(M^{n+})(HCrO_4^-)$ at 25° and I = 0.20 M are 63.6 ± 6.1 (Np(IV)–Cr(VI)), 4.70 ± 0.14 (Th(IV)–Cr(VI)), and 1.93 ± 0.13 (Fe(III)–Cr(IV)). Values of $\Delta H°$ are 1.17, 3.67, and 3.09 kcal, respectively. The greater stability of the Np(IV) complex compared to that of Th(IV) is interpreted in terms of donation of 5f electron density from the cation to the chromium(VI). The spectra of the complexes are presented. (auth)

33220 CORRELATION BETWEEN GASEOUS ATOMIC SPECTRA AND THE ABSORPTION SPECTRA OF ATOMS ISOLATED IN NOBLE-GAS MATRICES. Carstens, Dean H. W.; Brashear, Wayne; Eslinger, Delano R.; Gruen, Dieter M. (Argonne National Lab., Ill.). Appl. Spectrosc.; 26: No. 2, 184-217(Mar-Apr 1972).

Although matrix perturbations affect the energies and intensities of atomic transitions, it has been found that the complex spectra of matrix-isolated metal atoms correlated remarkably well with electronic transitions involving the ground state of the analogous gaseous atoms. A series of line drawings is therefore presented, which depict these transitions for 64 neutral gaseous elements (including Th and U). In addition a set of tables is included, which gives the intensities and energies of all experimentally observed gaseous transitions involving the atomic ground state. The electronic configurations and state designations for the various states involved in these transitions are also listed. Two examples of the correlation between the spectra of gaseous and matrix-isolated atoms are discussed. (auth)

33221 URANIUM–OXYGEN LATTICE VIBRATIONS OF α-SODIUM AND MAGNESIUM MONOURANATES. Ohwada, Ken (Japan Atomic Energy Research Inst., Tokai). J. Chem. Phys.; 56: No. 10, 4951-6(15 May 1972).

Infrared spectra of α-sodium and magnesium monouranates were measured in the frequency region from 4000 to 90 cm^{-1}. A normal coordinate analysis of the optically active uranium–oxygen lattice vibrations of such compounds was carried out on the assumption of a simple chain model of infinite $[(UO_2)O_2]^{2-}_{\infty}$ neglecting sodium and magnesium atoms. On the basis of the results of these calculations, some of the observed bands were assigned reasonably to the uranium–oxygen lattice vibrations. The stretching and bending force constants for both the compounds were obtained and discussed in relation to the uranium–oxygen bond distances. (auth)

33222 PRECIPITATION AND HYDROLYSIS OF URANIUM(VI) IN AQUEOUS SOLUTIONS. VII. BOUNDARY CONDITIONS FOR PRECIPITATION FROM SOLUTIONS OF $UO_2(NO_3)_2$–KOH–K, Ba, La, AND Eu NITRATE. Tomazic, B.; Branica, M. (Rudjer Boskovic Inst., Zagreb). J. Inorg. Nucl. Chem.; 34: No. 4, 1319-32(Apr 1972).

The hydrolytic precipitation of uranium(VI) was studied over a large concentration range of uranyl nitrate solutions. It was shown that the presence of a neutral electrolyte (potassium, barium, lanthanum, or europium nitrate) controls the character of uranium(VI) precipitation boundary, which is caused by the specific coagulation and constitution effect of interaction of the above mentioned counter ions with negatively charged metastable colloid particles. The experimentally obtained slope of precipitation line: pH-log $UO_2(NO_3)_2$ was used to predict the average composition of hydrolytic species in equilibrium with the first solid phase formed in the system. This was correlated with possible reaction mechanism of precipitate formation. The quantitative analysis showed that the composition of the first precipitation product, which is formed at the precipitation boundary in a large concentration range of uranium(VI), corresponds to potassium and barium heptauranate, respectively. (auth)

33223 NEW COORDINATION COMPLEXES FORMED BY Th(IV) AND U(IV) TETRACHLORIDES AND CYANOGEN CHLORIDE. MacCordick, John; Kaufmann, Gerard (Univ., Strasbourg). Bull. Soc. Chim. Fr.; No. 1, 23-6(Jan 1972). (In French).

Liquid cyanogen chloride reacts with Th(IV) and U(IV) tetrachlorides to form additional complexes of the $MCl_4 \cdot 2CNCl$ type. This reaction is very different from that observed with methyl cyanide. Thermal decomposition was used to isolate and identify the known complex $ThCl_4 \cdot 4CH_3CN$ and the new compound $ThCl_4 \cdot 2CH_3CN$ from the $ThCl_4-CH_3CH$ system. Far infrared spectra and thermogravimetric and magnetic susceptibility measurements suggest that these compounds have polymeric structures. (France)

33224 FORMATION OF COMPLEXES BETWEEN CHLORINE TRIFLUORIDE MONOXIDE AND PHOSPHORUS PENTAFLUORIDE OR URANIUM PENTAFLUORIDE. Bougon, Roland (CEA–CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. C; 274: No. 7, 696-8(14 Feb 1972). (In French).

Two new $ClOF_3$ complexes were prepared with PF_5 or UF_5. Raman and NMR spectroscopy revealed that they had the following ionic structure: $ClOF_2^+ PF_6^-$ and $ClOF_2^+ UF_6^-$. (France)

Radioactive Waste Treatment

Refer also to abstract 35546.

33225 (ARH-1982) ANION EXCHANGE RECOVERY OF RHODIUM FROM PALLADIUM-FREE ALKALINE SOLUTIONS. Panesko, J. V. (Atlantic Richfield Hanford Co., Richland, Wash. Separations Chemistry Lab.). Mar 1972. Contract AT(45-1)-2130. 15p. Dep. NTIS.

Strongly basic anion exchange resin removed rhodium from alkaline Purex supernatant wastes from which cesium and palladium had been removed. A 2 cm^3 resin bed was recycled 14 times using 250 bed volumes of feed per loading cycle. Removal of rhodium from the resin was accomplished by elution with nitric acid. (auth)

33226 (DP-768) RECOVERY OF NEPTUNIUM FROM STORED PUREX WASTE. Snyder, Mark D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sep 1962. Contract AT(07-2)-1. 16p. Dep. NTIS.

Declassified 28 Oct 1971.

A process was developed for recovery of neptunium from the sludge in stored alkaline wastes from the Purex process at Savannah River. The process involves dissolution of the sludge with HNO_3, addition of KF to the solution and heating to avoid gel formation, addition of $Al(NO_3)_3$ to complex the fluoride, and adjustment to about 8M total NO_3^-, 0.10M N_2H_4, and 0.05M $Fe(NH_2SO_3)_2$ for absorption of the neptunium by an agitated bed of anion resin. Laboratory tests with actual sludge showed a recovery of about 90% of the neptunium and a separation factor from fission products in excess of 10^3. Data on the viscosity of sludge-supernate mixtures and on the settling rate of the sludge particles were obtained for possible use in the design of equipment to remove sludge from the waste tanks. (auth)

33227 (HW-74568) RECOVERY AND PURIFICATION OF CESIUM FROM PUREX FORMALDEHYDE-TREATED WASTE BY INORGANIC ION EXCHANGE. Nelson, J. L.; Alkire, G. J.; Mercer, B. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 2 Aug 1962. Contract AT(45-1)-1350. 26p. Dep. NTIS.

Declassified 3 Nov 1971.

A flowsheet is presented for the removal, purification, and concentration of cesium from Purex formaldehyde-treated waste (FTW). Cesium and a small part of the sodium and hydrogen ions in the waste are adsorbed on the mineral clinoptilolite, while other cations and radionuclides, except $^{95}Zr-^{95}Nb$, are only slightly adsorbed. The bulk of the sodium and $^{95}Zr-^{95}Nb$ is removed with an oxalic acid wash and the cesium is subsequently eluted with ammonium carbonate. The ammonium carbonate is removed by volatilization, leaving a relatively pure cesium carbonate solution. Based on laboratory-scale experiments with simulated 1965 FTW, decontamination factors for strontium, cerium, and ruthenium are 2.1×10^3, $>9 \times 10^4$, and $>1.4 \times 10^5$, respectively. Sodium DF's of 10^3 to $>10^4$ are obtained along with a thirtyfold increase in cesium concentration. (auth)

33228 (ICP-1004) FOURTH PROCESSING CAMPAIGN IN THE WASTE CALCINING FACILITY, FY-1971. Wielang, J. A.; Lohse, G. E.; Hales, M. P. (Allied Chemical Corp., Idaho Falls, Idaho). Mar 1972. Contract AT(10-1)-1375. 45p. Dep. NTIS.

For the first time, high-level radioactive wastes were calcined to solids in the Waste Calcining Facility utilizing in-bed combustion heating. The Fourth Processing Campaign extended from August 3, 1970, to January 5, 1971, and 217,000 gallons of zirconium-fuel waste and 7,100 gal of aluminum-fuel waste were calcined in an air-fluidized bed heated to 500°C by means of the in-bed combustion of kerosene. The on-stream time was 100%. Use of the in-bed combustion was a major achievement; it made possible a maximum calcination feed rate of 67 gal/h of zirconium-fluoride liquid waste. (auth)

33229 (INIS-mf-204) STUDIES ON THE LEACHING KINETICS OF PHOSPHATE GLASSES WITH REGARD TO THE SOLIDIFICATION OF RADIOACTIVE WASTES. Sedighi-Dehkordi, N. (Technische Universitaet, Berlin (West Germany)). 18 Feb 1971. 96p. (In German). INIS.

In the three-component systems $P_2O_5-Al_2O_3-M(I)_2O$, or M(II)O, and $P_2O_5-Fe_2O_3-M(I)_2O$, or M(II)O (where M = Na, Sr, Cs) the region of glass formation was studied. The glass formation tendency decreased from Na over Sr to Cs. The kinetics of Na and Cs isotope exchange between an Al phosphate glass or mixed-alkali glass and salt melts on the one side, and between Fe phosphate glasses and 1 N CsI- and NaI-dimethylformamide solutions on the other was investigated. From the results the diffusion coefficients for Na and Cs were calculated. As to the mixed-alkali glasses, an ion exchange with the salt melt was superimposed on the isotope exchange. This could be suppressed by working in equilibrium melts. Long-time leaching of the glasses in distilled water of pH 4 showed the participation of a corrosion process as well as of a diffusion process. At lower temperatures a linear dependence of the leached part of alkali ions on $\sqrt{t}$ was found, showing a volume diffusion as rate–determining step, whereas the leached amounts of P_2O_5, Fe_2O_3, and Al_2O_3 tended to a linear dependence on the time (t), thus indicating corrosion. Moreover, the influence of fission products on the water resistance of the glasses was studied. With the exception of ZrO_2 and MoO_3, they bring about an improved stability against water leaching. (INIS)

Radioisotope Production

Refer also to abstract 33062.

33230 (BARC/I-140) PURIFICATION OF ^{237}Np. Patil, S. K.; Prakash, Satya; Dange, S. P.; Swarup, Rajendra; Ramaniah, M. V. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 7p. INIS.

Neptunium-237 can be formed by two reactions in the neutron irradiation of uranium. $^{238}U(n,2n)^{237}U \xrightarrow[6.75\ d]{\beta^-} {}^{237}Np$ and $^{235}U(n,\gamma)$ $^{236}U(n,\gamma)^{237}U \xrightarrow[6.75\ d]{\beta^-} {}^{237}Np$. While producing neptunium dioxide commercially, some impurities are likely to be present. Experiments carried out to purify a commercial sample of neptunium dioxide obtained from Oak Ridge National Laboratory, USA, are discussed. Methods of purification such as solvent extraction, anion exchange, spectrographic analysis, and electrodeposition are reported. The alpha spectrum of the original ^{237}Np solution showed the presence of ^{239}Pu and ^{238}Pu of the order of 26 and 2% in terms of disintegration rate. TTA extraction was found to be good in separating neptunium from plutonium as it extracts only Np(IV) leaving Pu(III) in the aqueous phase. The purified Np solution was electrodeposited on a gold plated aluminium foil and the alpha spectrum was taken which showed a pure spectrum of ^{237}Np. (INIS)

33231 (DP–741) PURIFICATION OF NEPTUNIUM RECOVERED FROM PUREX WASTE. Burney, Glenn A.; Prohaska, Charles A. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sep 1962. Contract AT(07-2)-1. 19p. Dep. NTIS.

Declassified 26 Oct 1971.

An ion exchange process was demonstrated to be satisfactory for the purification of ^{237}Np recovered from Purex process wastes at Savannah River Plant. Two cycles of anion exchange and one cycle of cation exchange gave the required separation from the major impurities (plutonium, thorium, and fission products). (auth)

33232 (SRARI-P–110) DETERMINATION OF THE TRANSURANIUM ELEMENT YIELD DURING IRRADIATION OF PLUTONIUM IN THE SM-2 REACTOR CENTRAL CHANNEL. Gabeskiriya, V. Ya.; Gryzin, Yu. I.; Gryzina, V. V.; Levakov, B. I.; Polyukhov, V. G.; Yakovlev, G. N. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1971. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

The estimation of plutonium, americium, curium, berkelium, californium, and einsteinium isotope yields by radiochemistry and mass spectrometry was made depending on the neutron dose during irradiation of Pu isotopes in the CM-2 reactor. By the yields obtained the effective cross sections of Pu, Am, Cm, and Cf isotopes were calculated and their buildup evaluated. (auth)

33233 ELECTRODEPOSITION OF AMERICIUM AND OBSERVATION OF THE SURFACE BY MEANS OF ALPHA PARTICLE TRACKS ON A CELLULOSE NITRATE FILM. Hashimoto, T. (Kyoto Univ.). J. Radioanal. Chem.; 9: No. 2, 251-8(Dec 1971).

The optimum conditions for high electrodeposition yields of trace amounts of americium on a stainless steel plate and aluminum foil were studied. In the case of a stainless steel cathode, the following conditions can be recommended: electrolyte, 10 ml of a 0.1M ammonium oxalate buffer solution with 0.5 ml of the americium stock solution (7 : 93 v/v, HNO_3); current density, 86 mA/cm^2; deposition time, 60 min. The uniformity of the deposited ^{241}Am was examined with a conventional α-track method with a cellulose nitrate film as a track-recording material. Clear tracks on this film were obtained with a polyester film (18 μ) as α-absorber placed between the deposited americium source and the cellulose nitrate film. (auth)

33234 CONCENTRATION OF CESIUM AND FRANCIUM BY DISTRIBUTION AND ADSORPTION CHROMATOGRAPHY. Maltseva, N. S.; Gavrilov, K. A. (Joint Inst. for Nuclear Research, Dubna, USSR). J. Radioanal. Chem.; 10: No. 2, 173-80(Apr 1972).

Methods were developed for concentrating cesium and francium from nuclear reaction products using distribution and adsorption chromatography. The feasibility of obtaining concentrated solutions of cesium and francium, both on carriers and carrier-free, was demonstrated. (auth)

Reactor Fuel Reprocessing

Refer also to abstract 33845.

33235 (ANL–7902) CHEMICAL ENGINEERING DIVISION, FUEL CYCLE TECHNOLOGY QUARTERLY REPORT, OCTOBER–DECEMBER 1971. Webster, D. S.; Jonke, A. A.; Bernstein, G. J.; Levitz, N. M.; Miller, W. E.; Steindler, M. J.; Vogel, R. C. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 49p. Dep. NTIS.

During the period October through December 1971, work was done in the following areas: (1) experiments to determine proper operating conditions and equipment design for a simplified zinc-decladding process to prepare long-cooled UO_2-PuO_2 for aqueous processing and additional experiments to study the decladding-reduction procedure with unirradiated UO_2 pellets and an intact irradiated fuel element, (2) three runs with uranyl nitrate solution and two initial runs with mixed U/Pu solutions in the pilot-scale reactor for production of UO_2-PuO_2 by denitration of uranyl nitrate and plutonium nitrate in nitric acid, (3) further study of the effects of bulk density and particle size on x-ray fluorescence signals in determining Pu/U ratios for oxide fuels in the form of green pellets and sintered pellets, (4) continued investigation of the effects of operating conditions on the separating capacity of a centrifugal contactor (for plutonium isolation steps in solvent extraction) when operated with a mixing chamber and in the annular mixing mode, and (5) design and construction of an electrolytic cell for the reduction of plutonium(IV) in nitric acid. (auth)

33236 (BMBW-FBK–71-17, pp 17.1-25) ISOLATION OF PROTACTINIUM FROM SINGLE-FLUID MOLTEN-SALT BREEDER REACTOR FUELS BY SELECTIVE EXTRACTION INTO Li–Th–Bi SOLUTIONS. Ferris, L. M.; Mailen, J. C.; Smith, F. J.; Nogueira, E. D.; Shaffer, J. H.; Moulton, D. M.; Barton, C. J.; Ross, R. G. (Oak Ridge National Lab., Tenn.). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The carrier salt for a single-fluid molten salt breeder reactor will be a mixture of ^7Li, Be, and Th fluorides, e.g., $LiF-BeF_2-ThF_4$ (72–16–12 mole %). The reactor can be fueled initially with either ^{235}U, ^{233}U, or ^{239}Pu. To maintain a breeding ratio of greater than 1, the salt must be chemically processed continuously to selectively remove the ^{233}Pa formed. The desired separation can be made using a reductive extraction process in which the molten salt is contacted with liquid Li–Th–Bi solutions at about 600°C. When the lithium concentration in the bismuth is low, uranium and/or plutonium are extracted preferentially into the bismuth; by increasing the lithium concentration, protactinium is extracted and separated from thorium. Distribution coefficients, defined as D_M = mole fraction of M in the bismuth phase/mole fraction of M in the salt phase, were determined at 500 to 700°C using a variety of $LiF-BeF_2-ThF_4$ salts. Theoretically, a plot of log D_M vs log D_{Li} should give a line with a slope equal to the valence of M (as its fluoride, MF_n) in the salt phase. The experimental data showed that protactinium existed as a tetravalent species (probably PaF_4) in the salt, and that uranium was present primarily as a trivalent species when the lithium concentration in the bismuth was greater than about 0.004 at. %. (auth)

33237 (BMBW-FBK–71-17, pp 32.1-14) SEPARATION CHEMISTRY OF PROTACTINIUM. Brown, D. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The separation and purification of protactinium is discussed concentrating mainly on the more recently reported separations. The methods considered include coprecipitation or adsorption; solvent extraction (ion pairs, chelates, solvates, and liquid metals); ion exchange; paper chromatography + electrophoresis; and preparative methods. Many of the methods discussed can also be applied to the separation of trace amounts of protactinium isotopes from irradiated thorium. (D.H.M.)

33238 (DOCKET-50201–120) WEST VALLEY REPROCESSING PLANT. Fuel Receiving and Storage Cooling Modification Safety Analysis. (Nuclear Fuel Services, Inc., Rockville, Md.). 17 May 1972. 6p. Dep. NTIS.

A safety evaluation was made of the proposed modification of the fuel receiving and storage area cooler. The modification is being made to improve the margin of safety for removing the decay heat of fuel in storage. It was concluded that it does not involve either a change in a technical specification or an unreviewed safety question. (M.C.G.)

33239 (DP–799) PERFORMANCE OF ADAKANE 12 AS PUREX DILUENT. Wilhite, Richard N. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Feb 1963. Contract AT(07-2)-1. 23p. Dep. NTIS.

Declassified 26 Oct 1971.

Precise physicochemical measurements were made on samples of solvent from the first cycle of the Purex process during the initial plant test of "Adakane 12" as diluent. Fewer degradation products were detected than were observed when refined kerosene was used. (auth)

33240 (HW–78444) DISSOLUTION OF NICKEL-PLATED ALUMINUM-JACKETED FUEL ELEMENTS. Schulz, W. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jul 1963. Contract AT(45-1)-1350. 37p. Dep. NTIS.

Declassified 2 Nov 1971.

Dissolution properties of electroless nickel plate are discussed.

Experiments were performed with both nickel-plated aluminum coupons and Hanford internally and externally cooled (I&E) fuel elements jacketed in nickel-plated aluminum. Nickel plate was chemically deposited by catalytic reduction of nickel(II) in the presence of hypophosphite ion. Nickel plate in both the as-deposited and equilibrium (heat-treated) forms is very resistant to attack by alkaline solutions; but both forms dissolve readily in boiling HNO_3 and $UO_2(NO_3)_2-HNO_3$ solutions. Heat-treated plate, however, dissolves about 35 times faster in 1.0M HNO_3 than as-deposited plate. Plate on the inner aluminum surface of the I&E elements differs significantly from plate on the outer aluminum surface since it is resistant to chemical attack by HNO_3 as well as by alkaline solutions. Boiling $NaOH-NaNO_3$ and HNO_3 solutions, however, undercut the inner plate to expose the underlying uranium metal core. (auth)

33241 (IDO-14524) REVIEW OF PROCESSES FOR THE RECOVERY OF CERAMIC NUCLEAR FUELS. Slansky, C. M.; Decker, L. A.; Rohde, K. L. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). 21 Nov 1960. Contract AT(10-1)-205. 32p. Dep. NTIS.

Declassified 26 Oct 1971.

Five possible flowsheets for processing ceramic nuclear fuels containing beryllium oxide and uranium dioxide are described. The process approaches are grind-nitric acid leach, two-step dissolution in sulfuric and nitric acids, dissolution in fused ammonium bifluoride, chlorination at 550°C, and hydrofluoric acid dissolution-calcium fluoroberyllate precipitation. Advantages and disadvantages of each approach are given. The chemistry of beryllium and yttrium is reviewed with respect to flowsheet applications. The health and safety aspects of beryllium process studies are discussed. (auth)

33242 (IDO-14585) CERAMIC FUEL REPROCESSING PRELIMINARY DISSOLUTION AND LEACHING STUDIES. Decker, L. A. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). 1 Jun 1962. Contract AT(10-1)-205. 36p. Dep. NTIS.

Declassified 26 Oct 1971.

The process chemistry of each of four proposed development flowsheets for processing ceramic nuclear fuels was investigated. The flowsheets were molten ammonium bifluoride dissolution, grind-leach recovery, sulfuric acid dissolution, and aqueous hydrofluoric acid dissolution. The fuels used in the study were General Electric's ceramic direct-air-cycle fuel and Pratt and Whitney's metal-clad ceramic indirect-cycle fuel for nuclear aircraft. Successful dissolution of the metal-clad ceramic fuel was obtained with molten ammonium bifluoride at the boiling point. Dissolution of the General Electric ceramic fuel was obtained with sulfuric acid. Flowsheets using the experimental results were devised. Dissolution rates of several refractory oxides and metals were obtained over the liquid temperature range of ammonium bifluoride. These materials were aluminum oxide, zirconium oxide, beryllium oxide, molybdenum, titanium, niobium, zirconium, and niobium-0.75% zirconium alloy. Only 75 to 80% of the uranium could be recovered from the ceramic fuel by a grind-leach process. Sixty percent of the uranium could be leached from the unground fuel. Very little success was obtained with aqueous hydrofluoric acid dissolution of either of the fuels. (auth)

33243 (ORNL-TM-3258) ENGINEERING DEVELOPMENT STUDIES FOR MOLTEN-SALT BREEDER REACTOR PROCESSING NO. 8. McNeese, L. E. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 31p. Dep. NTIS.

Research progress is reported on: analysis of the fluorination-reductive extraction and metal transfer flowsheets, uranium removal from fuel salt by oxide precipitation, development of a frozen-wall fluorinator, measurement of axial dispersion coefficients and gas holdup in open bubble columns, development of the metal transfer process, semicontinuous reductive extraction experiments in a mild-steel facility, prevention of axial dispersion in packed columns, electrolytic reduction of LiCl, purification of salt by continuous methods, and electrolytic oxidation of Pa^{4+} to Pa^{5+} in MSBR fuel salt. (M.C.G.)

33244 (PNC-N-831-70-2, pp 70-2) NEPTUNIUM SEPARATION FROM URANYL-NITRATE/NITRIC ACID SOLUTIONS WITH TUNGSTIC ACID EXCHANGER. Tsuboya, Takao; Kaya, Akira; Hoshino, Tadaya (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970.

Adsorption of neptunium(IV) on a tungstic acid exchanger is dependent on nitric acid concentration and neptunium concentration. For example, when the neptunium concentration of the supernatant liquid was 8.4×10^{-5} mole/l, the amount of neptunium adsorbed was 17, 12, and 5 mg on 1 g of tungstic acid in 1, 2, and 4N nitric acid, respectively. In the case of uranium, the amount of uranium adsorbed was 6 and <1 mg per 1 g of tungstic acid in 0.5 and 2N nitric acid, respectively. Consequently, it is possible to separate neptunium and uranium in nitric acid by column operation. In this case, neptunium is preferentially adsorbed on the tungstic acid bed. The tungstic acid used in the study was obtained as bluish-green glassy gel, and a portion of 48 to 100 mesh was used for batch experiments on the adsorption capacity measurement. A portion of 100 to 200 mesh was used for the column experiment. Neptunium stock solution was purified by TTA extraction to >99.9% of radiochemical purity (α particles). Valency of the purified neptunium was adjusted to IV by reaction with hydrazine in 5N nitric acid solution at 90°C. (Japan)

33245 (PNC-N-831-70-2, pp 73-4) DISTRIBUTION DATA IN 10% TBP/N-DODECANE Pu(III)-U-HNO_3 SYSTEM. Hoshino, Tadaya; Tsuboya, Takao; Yasu, Syozo; Tanaka, Chuzaburo (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-9).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Distribution data in a 10% TBP-n-dodecane system containing Pu(III) necessary for flowsheet design of the 2nd cycle are described. To prepare Pu(III) nitrate solution, ferrous sulfamate was used as reductant, and hydrazine nitrate as Pu(III) stabilizer. A certain volume of prepared solution and the same volume of solvent were shaken for 3 min in a polyethylene capsule, after adding the desired amount of Pu solution, and then allowed to settle for 10 min. Pu(III) in the aqueous phase was determined by α counting and Pu in the organic phase by the same method after back extraction with $NH_2OH \cdot HCl$. U was determined by colorimetry or titration. When the aqueous H^+ concentration was 0.2N, the Pu(III) distribution ratio decreased slightly with decreasing aqueous Pu concentration, but was not affected by aqueous U concentration. When the aqueous H^+ concentration was 2N, the Pu distribution ratio decreased slightly with increasing aqueous Pu concentration, and also with increasing aqueous U concentration. U distribution ratio was independent of the aqueous Pu in 0.2 to 2N acid concentration, and this trend became more significant with increasing aqueous acid concentration. The U distribution ratio became small when organic U concentration exceeded 3 to 4 g/l, and this tendency was more significant at higher acid concentration. (Japan)

33246 (PNC-N-831-70-2, pp 75-6) PROCESS STUDY ON AQUEOUS REPROCESSING OF JEFR FUELS. I. PROVING TEST OF THE FIRST CYCLE FLOW SHEET FOR CODECONTAMINATION PROCESS. Hoshino, Tadaya; Yasu, Syozo; Kawashima, Nobuyoshi; Tanaka, Chuzaburo (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-10).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

For reprocessing of spent JEFR fuel, a flowsheet for the first cycle (codecontamination process) was tested using mini-mixer-settlers. Results of this test and of a check for the theoretical number of stages are described. The theoretical number of stages was calculated by assuming that volume change of solution is negligible, and the concentration profile of aqueous nitric acid is approximately constant. It was concluded that the extraction section requires 3 stages for U and 6 stages for Pu; on the other hand, the strip section requires 3 stages each for U and Pu. Loss in the first cycle was 0.3% for U and less than 0.3% for Pu. It is also concluded from the concentration profile that 8 stages are necessary for the extraction and 6 stages for the stripping sections. (Japan)

33247 (PNC-N-831-70-2, pp 77-8) PROCESS STUDY FOR AQUEOUS REPROCESSING. VIII. IMPROVEMENT OF DECONTAMINATION FACTOR BY THE USE OF DBP COMPLEXES. Tsujino, Takeshi; Aochi, Tetsuo; Hoshino, Tadaya; Murase, Takeo (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-11).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

For applying the dilution effect and DBP masking of inactive zirconium to the aqueous reprocessing of high-burnup fuel, such as FBR fuel, a process study using mini-mixer-settlers was carried out with a flowsheet of a high DBP content system. The effect of adding F, Sc, Hf, and Mo is reported. Experiments were carried out by the continuous countercurrent extraction method. DBP was added to the solvent corresponding to the amount produced by once-through the cycle in FBR fuel treatment. Recovery of U and Pu higher than 99%, material balance of 97 to 99%, concentration profile, and phase stability were all satisfactory. Decontamination factors of active zirconium decreased by a factor of one-eighth in the presence of the DBP, and increased by a factor of four by addition of inactive zirconium. By addition of F, Hf, Sc, and Mo, the distribution ratio of active Zr decreased and the decreasing rate became larger with increasing DBP concentration. (Japan)

33248 DRY REPROCESSING OF NUCLEAR FUEL. Muramatsu, Takio; Sano, Katsunori (First Atomic Power Industry Group, Tokyo). FAPIG (Tokyo); No. 61, 29-32(May 1971). (In Japanese).

Wet and dry processes for the reprocessing of spent nuclear fuels are summarized. A few wet processes based on solvent extraction are discussed. Redox and Purex processes have been used for the separation of Pu, U, and fission products. Drawbacks to these processes include the necessity of cooling and decladding solid fuel, radioactive damage of solvent, an increased number of processes due to resolidification after dissolution, and the disposal of large amounts of radioactive wastes. Dry reprocessing includes the fluoride volatility process consisting of fluorination, adsorption, and distillation. The pyrometallurgical process, another dry process, is a separation method based on the principle of zone melting. Difficulties encountered with dry processes differ from those with the wet processes. (Japan)

33249 METHOD OF ELIMINATING STRONTIUM. Arod, Jean; Francais, Jacques; Gauchon, J. P. (to Commissariat a l'Energie Atomique). French Patent 2,068,158. 26 Jul 1971. Filed 28 Nov 1969. (In French).

A procedure for eliminating ^{90}Sr from radioactive effluents arising from the reprocessing of irradiated nuclear fuels is described. This process involves the alkalinization of the effluent by sodium nitrate at a pH at least equal to 10 in order to precipitate the magnesium present, and also filtration of the effluent and its passage across a carboxylic resin. The fixation power of carboxylic resins for Sr depends upon the sodium nitrate content, the pH, and the presence of Mg in the effluent. A polyacrylic resin is used as the carboxylic resin. A 1M nitric solution is used to elute the resin. (France)

33250 SYNERGIC PHENOMENA CONNECTED WITH SOLVENT EXTRACTION. Madic, C. (CEN, Fontenay-aux-Roses, France). Chim. Anal. (Paris); 54: No. 2, 102-13(Feb 1972). (In French).

Solvent extraction methods are very suitable for processing fuel or irradiated targets. The discovery of synergism in 1954 further extended their range of applications. The subject is presented bibliographically: an introduction dealing with the historical background and the different terms defining the phenomena; the three main methods of study; the detailed analysis of various instances of synergism observed in the course of studies of thenoyltrifluoroacetone. An overall classification of synergism phenomena studied up to the present is given. The last section covers analytical and industrial applications envisaged in the future. (France)

33251 TECHNICAL PROBLEMS IN PLUTONIUM STORAGE. Nakamura, Yasuji (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 17: No. 11, 33-8(Nov 1971). (In Japanese).

Storage of plutonium obtained by reprocessing became an important technical problem. Since recovery cost of the plutonium from natural uranium is higher than that from enriched uranium, cost of the plutonium is high at present. Therefore, storage of spent fuel will be necessary until the reprocessing cost becomes cheap or until development of fast reactors is promoted. If the cost of plutonium is cheap, a fuel cycle with plutonium recycle in light-water reactors is economical enough at present. Decay series of plutonium and its daughter nuclides must be taken into consideration for treatment of the plutonium. Their nuclear characteristics are given. Then, for the storage of plutonium, three modes of metal, oxide or its compound, and plutonium nitrate solution can be employed. Therefore, technical problems of the storage must be considered carefully in view of their chemical and nuclear properties. (Japan)

ENGINEERING

Energy Conversion

Refer also to abstract 34486.

33252 (N–72–14027) COMPUTER CONTROLLED PERFORMANCE MAPPING OF THERMIONIC CONVERTERS: EFFECT OF COLLECTOR, GUARD-RING POTENTIAL IMBALANCES ON THE OBSERVED COLLECTOR CURRENT DENSITY, VOLTAGE CHARACTERISTICS, AND LIMITED-RANGE PERFORMANCE MAP OF AN ETCHED-RHENIUM, NIOBIUM PLANAR CONVERTER. Manista, Eugene J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1972. 15p. (NASA-TM-X–2480; E–6446). NTIS.

The effect of collector, guard-ring potential imbalance on the observed collector-current-density (J) and collector-to-emitter voltage (V) characteristic was evaluated in a planar, fixed-space, guard-ringed thermionic converter. The JV characteristic was swept in a period of 15 msec by a variable load. A computerized data acquisition system recorded test parameters. The results indicate minimal distortion of the JV curve in the power output quadrant for the nominal guard-ring circuit configuration. Considerable distortion, along with a lowering of the ignited-mode striking voltage, was observed for the configuration with the emitter shorted to the guard ring. A limited-range performance map of an etched-rhenium, niobium, planar converter was obtained by using an improved computer program for the data acquisition system. (auth) (STAR)

33253 (N–72–14028) COMPUTER-ACQUIRED PERFORMANCE DATA FROM AN ETCHED-RHENIUM, MOLYBDENUM PLANAR DIODE. Manista, Eugene J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Jan 1972. 15p. (NASA-TM-X–2481; E–6610). NTIS.

Performance data from an etched-rhenium, molybdenum thermionic converter are presented. The planar converter has a guard-ringed collector and a fixed spacing of 0.254 mm. The data were acquired by using a computer and are available on microfiche as individual or composite parametric current, voltage curves. The parameters are the temperatures of the emitter T_E, collector T_C and cesium reservoir T_R. The composite plots have constant T_E, and varying T_C or T_R, or both. The envelope and composite plots having constant I_E are presented. The diode was tested at increments between 1500 and 2000°K for the emitter, 750 and 1100°K for the collector, and 540 and 640°K for the reservoir. In all, 774 individual current, voltage curves were obtained. (auth) (STAR)

33254 MAGNETOHYDRODYNAMIC ELECTRIC POWER GENERATION WITH NUCLEAR PRE-IONIZATION IN HELIUM-COOLED FAST BREEDER REACTORS. Imani, Kuzutake. Gainesville, Fla.; Univ. of Florida (1971). 161p. University Microfilms Order No. 72-12,479.

Thesis.

Analytical and experimentally simulating methods are presented of nuclear pre-ionization in Gas-Cooled Fast Reactors (GCFR) which have possible applications for magnetohydrodynamic (MHD) generators. In a GCFR core, fast neutron recoil ionization of helium (He) is found to generate an electron source of over 10^{16} 1/cm^3 sec and a maximum electron density of approximately 10^{13} 1/cm^3. Ionization from fission fragments is substantial; however, the fission products contaminate the coolant system and degrade the MHD performance. Calculations of the electron density are made for a GCFR, followed by a potassium seeder, a nozzle, and an electric pre-ionizer, taking into account the electron production and recombination and the thermodynamic parameters of the He coolant. The nuclear pre-ionization due to fast neutron recoil is calculated to be enough for the electric pre-ionizer, where the initial electron density should be higher than approximately 10^{10} 1/cm^3. The analytical study of nuclear pre-ionization due to fast neutron recoiled He, fission fragments, and gamma rays is based on experimental simulation using ^{3}He ionization chambers, fission chambers and ^{60}Co gamma source, respectively. The pulsed ionization chamber (PIC) plasma diagnostic technique is applied to the study of the kinetics of plasmas produced under conditions compatible with high-temperature gas-cooled nuclear reactor-MHD generator environments as part of a research program on nuclear methods of pre-ionization. Plasma production by fission fragments and ^{3}He (n,p) ^{3}H reaction products in He and several gas mixtures, and their subsequent decay by various loss mechanisms, are measured using the PIC method in the University of Florida Training Reactor and also in the Van de Graaff proton accelerator. The PIC chamber is operated as a function of gas pressure (1 to 27 atm) and temperature (300 to 823°K) over a wide range of ionization source rates (10^7 to 10^{14} 1/cm^3 sec) and electron densities (10^5 to 10^{11} 1/cm^3). The theoretical and numerical solutions for the PIC system operational characteristics are presented along with experimental demonstrations of their validity. Numerically fitted data from measured voltage pulse profiles and loss coefficients for He plasmas measured by this method are presented. Also, the PIC method is analyzed to evaluate its application to the fast-response measurement of the neutron flux in a Liquid-Metal-cooled Fast Breeder Reactor (LMFBR). The experimental second-order recombination coefficient (α_2) is compared with the theory, which includes the effects of columnar recombination, neutral-atom-stabilized dissociative recombination of He_2^+ and He_3^+, and molecular impurity ions such as N_2^+. The columnar recombination effect for α_2 is experimentally found to be important for ionizing columns generated by ^{235}U fission fragments, but not important for columns generated by ^{3}He(n,p)^{3}H reaction products or ^{60}Co gamma rays. (Diss. Abstr. Int., B)

33255 TERMOELEKTRICHESKIE GENERATORY. (Thermoelectric Generators). Okhotin, A. S.; Efremov, A. A.; Okhotin, V. S.; Pushkarskii, A. S. Moscow; Atomizdat (1971). 288p.

Various aspects of the thermoelectric method of thermal-to-electric energy conversion are examined. Physical and power fundamentals of thermoelectricity, the current status of the physics of thermoelectrical process, properties of semiconductor materials, and techniques for calculating simple and complex thermoelectrical structures are discussed. Descriptions of thermoelectric generators of various types, designs, and purposes are included. (168 drawings, 23 tables, 222 references) (auth)

33256 ENERGY LOSS IN LIQUID METAL MHD INDUCTION CONVERTER DUE TO DISCRETE TOOTH-SLOT ARRANGEMENTS. Tanatugu, Nobuhiro; Fujii-E, Yoichi; Suita, Tokuo (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo) 9: No. 4, 213-23(Apr 1972).

The performance characteristics of a linear channel LM-MHD induction converter operated in both constant current and constant voltage mode are obtained analytically, applying the slit channel approximation and taking account of variations in the traveling magnetic field intensity in the direction of the fluid flow according to differences in the disposition of the teeth and slots in the stators. The analytically obtained solutions were verified with the experimental converter with and without copper side bars operated in constant voltage mode at room temperature using NaK-78 as the electrically conducting working fluid. The experimental results obtained with the converter with copper side bars agreed with the analytically obtained solutions, though the plots of power output shifted toward greater values of negative slip compared with the theoretical curves, due to the additional ohmic losses in both the side walls of channel and the copper side bars, which were not taken into account in the present analysis. (auth)

33257 SOLUTION FOR THE VARIATIONAL PROBLEM OF CONSTRUCTING AN OPTIMUM MHD GENERATOR. Kraiko, A. N.; Slobodkina, F. A. Magn. Gidrodin.; No. 4, 53-7(Oct-Dec 1971). (In Russian).

Problems connected with a definite form of the channel are examined for a solution of the variational problem of constructing an MHD generator of maximum power. Reasons are advanced which aid in the formulation of variational problems with correct application of one-dimensional equations, and as a consequence the appearance in the solution of corresponding portions of a boundary extremum. (tr-auth)

33258 ANALYSIS OF UNIVERSAL CHARACTERISTICS OF MHD MACHINES. Ushakov, Yu. P. Magn. Gidrodin.; No. 4, 110-16(Oct-Dec 1971). (In Russian).

For the example of the pumping type of operation, an analysis of the three types of MHD machines (induction, sequential conduction, and independent excitation) yields the power characteristic $\eta = f(\Delta p, Q)$. It is noted that this analysis is applicable to the generation type of operation, and also to shielded electrical machines. The maximum possible efficiency may be achieved for fully defined magnetic induction, which is always less than the saturation induction of the magnetic system of a machine. Depending on the type of approximating function of magnetization, the ratio between the optimum induction and the saturation induction may amount to $^2/_3$ or $^3/_4$. The ultimate refinement of the mathematical model may be attained by means of substitutions of assumptions concerning temperature constancy, in consideration of temperature oscillations in various elements of the structure, etc. (tr-auth)

33259 FIELD STRUCTURE IN MHD MACHINES WITH A DIVERGENT MAGNETIC CIRCUIT. Ogorodnikov, A. P. Magn. Gidrodin.; No. 4, 105-9(Oct-Dec 1971). (In Russian).

Using an approximation model of a MHD machine, and without allowing for magnetic saturation effects, an analytical expression was obtained for magnetic induction in an operating gap for an open-circuit path. In similar MHD machines, besides a pulsating field created by the shunting of the magnetic flux, there arises a pulsating field which is caused by the expansion of the magnetic circuit. Conditions were found for which the pulsating field was absent. Experimental results support the validity of the theoretical solution. (tr-auth)

33260 OPERATION OF AN EHD GENERATOR IN A THERMODYNAMIC CYCLE. Bortnikov, Yu. S.; Nesterov, V. A.; Rubashov, I. B. Magn. Gidrodin.; No. 2, 141-2(Apr-Jun 1971). (In Russian).

Various EHD designs are related to the nature of the operating substance. The over-all efficiency of a unit showed that it does not depend on the internal efficiency of the generator but is determined solely by the electrical parameters of the operating substance. Methods for enhancing the effectiveness of an EHD converter are noted. Graphs are presented which show the dependence of the useful efficiency of a unit on the level of the pressure in the cycle for different operating substances, so that a substance with the desired parameters may be selected. (tr-auth)

33261 MIXED-TYPE GENERATORS. Pleshanov, A. S. Magn. Gidrodin.; No. 4, 58-62(Oct-Dec 1971). (In Russian).

Quasi-one-dimensional equations of motion and energy for an electrically conducting continuous medium in external fields, taking account of excessive charge in a non-viscous and non-heat-conducting approximation, may be reduced to a common form employed in MHD for an appropriate fixed electromagnetic field. The specific power of such a generator of a mixed type may be large as compared to an ordinary MHD generator for a significant divergence from quasi-neutrality. The local condition for the optimum partitioning of a mixed-type generator was obtained. As in the case of an ordinary MHD generator, an increase in the magnetic field raises the effectiveness of an optimal generator of the mixed type. (tr-auth)

33262 COMBUSTION MHD GENERATOR AS EMERGENCY STAND-BY UNIT FOR POWER SUPPLY SYSTEMS. Buende, R. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.); Muntenbruch, H.; Helm, S. Brennst.-Waerme-Kraft; 24: No. 3, 94-8(1972). (In German).

A brief discussion of the various possible applications of combustion MHD generators is presented along with a detailed account of the possibilities for using a combustion MHD generator for short-period operation. Its suitability as an energy stand-by unit in an electric grid is determined with reference to three examples, and compared from a technical and economic stand-point with that of other systems for providing emergency power. (auth)

33263 MHD CENTRAL POWER: A STATUS REPORT. Dicks, J. B. (Univ. of Tennessee, Tullahoma). Mech. Eng.; 94: No. 5, 14-20(May 1972).

Principles of MHD generators are reviewed followed by projections of future development of MHD. Information is presented on development of MHD in the U. S., USSR, West Germany, and other countries. An evaluation of MHD development status in the U. S. is included. (J.R.D.)

Facilities and Equipment

Refer also to abstracts 33679 and 33985.

33264 (ARH-2379) WASTE PROCESSING TELEVISION PROBE CAMERA. Schildknecht, W. D. (Atlantic Richfield Hanford Co., Richland, Wash.). 25 Feb 1972. 10p. Dep. NTIS.

The design of a television camera which can pass through a vessel opening as small as three inches in diameter is presented. The camera was developed for inspecting the interior of nuclear waste vessels, for analyzing equipment failures, or for determining the effectiveness of chemical flushes. (W.H.K.)

33265 (CNLM-6068) SNAP-50/SPUR PUMP DEVELOPMENT PROGRAM. Kelly, R. W.; Wood, G. M. (Pratt and Whitney Aircraft, Middletown, Conn.). 31 Dec 1964. Contract AT(30-1)-2789. 18p. Dep. NTIS.

Declassified 5 Nov 1971.

Research is reported on film bearings, hydraulics, materials, motors, instruments, design concepts, seals, pump structures, and integration of designs. (J.R.D.)

33266 (NP-19324) NEWSLETTER IN STEREOLOGY: QUANTITATIVE IMAGE ANALYSIS WITH ELECTRONIC IMAGE ANALYZERS. Ondracek, Gerhard (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Dec 1971. 114p. (In German). Dep. NTIS (U. S. Sales Only).

Ten articles on quantitative image analysis are presented. Information is included on new measuring methods; sources of errors in image analysis measurements; an explanation of the different tube types such as Orticon, Vidicon and Plumbicon and their advantages and limitations; the contribution of the optical equipment to the accuracy of measurement; and possible microscopic errors. Examples of future applications in materials science as well as in nuclear physics, biology, and medicine are discussed. (auth)

33267 (RDT-E-1-25-T(4-72)) INSTRUMENT VALVES. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Apr 1972. 15p. RSO.

This standard covers forged-body, manually operated globe valves (1'' and smaller) for applications in a nuclear energy system. The other documents that are a part of this standard are listed. Technical requirements, quality assurance requirements, preparation for delivery, and ordering data are included. (R.W.R.)

33268 (WaBoLu-5/70) CRITERIA AND RECOMMENDATIONS FOR THE DESIGN OF VENTILATING DEVICES FOR CONTAMINATED EXHAUST AIR IN BUILDINGS. Fett, W. (Bundesgesundheitsamt, Berlin (West Germany). Institut fuer Wasser-, Boden- und Lufthygiene). Sep 1970. 24p. (In German). INIS.

A review is presented of the state of knowledge which should be considered for the design of exhaust hoods for air pollutants (among others radioactive gases) from buildings or building complexes (e.g. reactor hall), namely from labs, and for the design and construction of the buildings. Criteria for the cavity zone obtained by means of wind tunnel tests: formation of cavity zone; flow in cavity zone; contamination of cavity zone. First recommendations are derived from these criteria. Recommendations concerning the building: position; type; proportions and structures of the building. Recommendations concerning the exhaust hood and the ventilation: position of exhaust hood and ventilation; size of exhaust hood; operational procedure; emission limits. (INIS)

33269 PROCEDURE FOR MAINTAINING AN IRRADIATION RABBIT IN ROTATION IN A PNEUMATIC REACTOR TUBE AND THE NECESSARY EQUIPMENT. Junod, Eric; Laverlochere, Jean (to Commissariat a l'Energie Atomique). French Patent 2,074,702. 8 Oct 1971. Filed 20 Jan 1970. (In French).

A procedure is described for maintaining in rotation an irradiation rabbit in a vertical part of a pneumatic reactor tube near to the core. The procedure consists of maintaining the rabbit at a fixed height in the tube and causing it to rotate about a vertical axis by the action of compressed air on fins attached rigidly to the rabbit. The procedure is intended to compensate for the horizontal flux gradient existing in the reactor. (France)

33270 CONSTRUCTION OF A PORT FOR USUAL MOORAGE OF A NUCLEAR SHIP. Hayashi, Tadamasa (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen; No. 91, 2276-99(May 1971). (In Japanese).

Land for construction of a port was purchased in March 1968, and construction of the quay began in April 1968. The quay, buildings and a crane were completed from August to December, 1969, and the nuclear ship "Mutsu" has been in port since July 1970. Total floor area of the buildings is about 5,680 m^2, and main buildings are an office building, a fuel exchange shop, a waste disposal shop, a power station and a display building. The waste disposal shop and the display building are not yet completed. Handling of radioactive substances is confined within the fuel exchange shop and the waste disposal shop, and radiation control area is limited around these two shops. Most important point for the buildings in the radiation control area is ventilation rate, and the rate is stipulated for each room. The 75 ton quay crane, a 75 ton overhead crane, and ten smaller cranes and hoists are installed. Construction of a 312 KVA emergency generator and facilities for neutralizing waste liquid, waste disposal, fuel storage and fuel exchange was started in 1970. The waste disposal facility treats the waste liquid, waste resin from a desalter, paper and rag wastes, filter sludge from fuel pool cleaning, and waste liquids from an exchange tower, decontaminating facility and laundry. Methods employed are filtering, ion exchange, evaporation and cement solidification. The fuel storage facility is mainly for spent fuel, and it comprises a fuel storage pool, a bridge crane, fuel storage racks, damaged fuel detector, storage vessels for the damaged fuel, a cooler, a filter and an ion exchange tower for pool water. The fuel exchange facility comprises double rotary shield and casks for fuel exchange, structures within a reactor and neutron sources. (Japan)

33271 IMPROVEMENTS IN AND RELATING TO CREEP MEASURING CELLS. Cartier, Louis (to Commissariat a l'Energie Atomique). British Patent 1,272,673. 3 May 1972. Priority date 20 Jun 1968, France.

A creep measuring cell designed for use in reactor radiation fields is described. The cell comprises a vertical tubular container in which the test specimen is subjected to stress. The stress is applied by attaching the specimen to the tube at one end and to a bellows at the opposite end. The gas pressure in the bellows can be varied in such a way that known stress can be exerted on the specimen. Variations in specimen length are sensed and recorded. (J.R.D.)

Heat Transfer and Fluid Flow

Refer also to abstracts 33893, 34763, 35394, 35399, 35409, 35412, 35415, 35416, 35442, 35448, 35635–35638, 35644, and 35664.

33272 (INIS-mf–200) ONCE-THROUGH STEAM GENERATION. Sankovich, M. F.; McDonald, B. N. (Babcock and Wilcox Co., Lynchburg, Va.). 25 Mar 1971. 11p. (CONF-710317–6). INIS.

From sixteenth nuclear congress; Rome, Italy (25 Mar 1971).

The application of experimentally determined two-phase flow data and the progression of design to a pure "once-through steam generation" concepts are described. The Babcock and Wilcox nuclear steam generator operates with constant average reactor coolant temperature and provides superheated steam at constant turbine throttle pressure over a wide load range. (INIS)

33273 (LA–4882) MEASUREMENTS OF CONVECTIVE HEAT-TRANSFER COEFFICIENTS FOR THE SUBSONIC FLOW OF HYDROGEN AND HELIUM IN SMOOTH TUBES AT MODERATE SURFACE AND FLUID TEMPERATURES. Sullivan, J. A.; King, C. R. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 14p. Dep. NTIS.

Experimental investigations into the forced-convection heat transfer for helium and hydrogen flowing in smooth tubes were conducted at a nominal inlet temperature of 300°K, wall temperatures to 1475°K, exit-gas temperatures to 725°K, inlet Reynolds numbers from 10^4 to 7×10^4, and heat fluxes to 31.4 cal/sec cm^2. The length-to-diameter ratio of the test section was 87, and maximum wall-to-bulk temperature ratios in the experiments reached 1.9. The results agree well with a recently published correlation of experimental data, but preliminary comparisons of these data with a two-dimensional numerical solution for turbulent flow in a heated tube show only moderate agreement. (auth)

33274 (STU–70-386/U-317) DEPOSITION OF IMPURITIES ON HEAT TRANSFER SURFACES. THE THERMAL CONDUCTIVITY OF MAGNETITE DEPOSITS. Final Report. Rooth, Thord; Kelen, Tormod; Arvesen, Jan (Aktiebolaget Atomenergi, Studsvik (Sweden)). Sep 1971. 45p. Dep. NTIS (U. S. Sales Only).

In a study of the temperature increments due to deposits in BWR fuel elements and in boiler tubes, an investigation was made of the thermal conductivity of magnetite deposits. High pressure equipment was built for the experiments, which permitted boiling at a surface with densities of heat flow rate up to 800 kW/m^2 and pressures up to 70 bars. Using data from the experiments, the thermal conductivity and some other parameters were calculated. The highest thermal conductivity found was 1.47 and the lowest 0.18 W/m °C. Most of the values were in the range 0.3 to 0.7 W/m °C. The conductivities were all nearly independent of the density of heat flow rate in the investigated range of 300 to 800 kW/m^2. A literature investigation showed that the conductivity values agree well with values for deposits of mixed composition which are encountered in practice. The porosities of the deposits were in the range 70 to 90%, which is somewhat higher than the literature values. No correlation was found between the conductivity and the thickness of the deposits. The thicknesses were in the range 5 to 70 μm. It should be noted that the conductivity values are only valid for deposits of magnetite. (auth) (Sweden)

33275 FLUID-DYNAMIC STUDY OF FULLY DEVELOPED TURBULENT FLOW OF MERCURY IN ANNULI. Hlavac, P. J.; Nimmo, B. C.; Dwyer, O. E. (Brookhaven National Lab., Upton, N. Y.). pp 1-14 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

An experimental study of heat transfer to mercury in fully developed turbulent flow through smooth concentric annuli was carried out. The main purposes of the study were, first, to get comparisons between local eddy diffusivity of momentum transfer (ϵ_M) and eddy diffusivity of heat transfer (ϵ_H) values, and second, to determine the effects of wetting on both the fluid dynamics and the heat transfer. The fluid-dynamics portion of the study is presented. The eddy diffusivities of momentum transfer were correlated only moderately well by modified forms of the Kays–Leung and Eifler correlations. These modifications incorporated a slight increase in the Reynolds number effect. It is shown that the ratio of the maximum value of ϵ_M in the inner portion of an annulus to that in the outer portion is an explicit function of the radius ratio and is independent of Reynolds number. (auth)

33276 EXPERIMENTAL DETERMINATION OF LOCAL HEAT TRANSFER COEFFICIENTS IN AN ANNULAR SODIUM FLOW PASSAGE AT AND NEAR A FLOW OBSTRUCTION. Engel, F. C.; Bishop, A. A. (Westinghouse Advanced Reactors Division, Madison, Pa.). pp 50-7 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

An experimental study was made of the entrance turbulent heat transfer ratios h/h_∞ to sodium flowing upwardly in an internally heated annulus. Each of the two annular test sections used contained an obstruction in the form of a cylindrical spacer-sleeve or grid. Non-uniform, developing flow occurred at the upstream and downstream edges of the spacer. Heat transfer data were obtained within and downstream from the spacer for Reynolds numbers of 4.0×10^4 to 1.5×10^5, heat fluxes of 3.0×10^4 to 1.2×10^5 Btu/hr-ft^2, sodium temperatures of 600 to 950°F, and annular area ratios of 0.800 and 0.875. Local heat transfer coefficients, h, within the grid and downstream from the grid were higher than h_∞, the fully developed heat transfer coefficient; no hot spots were found within the grid. The values of h/h_∞ measured at corresponding values of L/De were considerably higher than for fluids having Prandtl numbers of the order of unity under similar conditions of non-uniform developing flow. The value of h/h_∞ was a function of L/De, and annular radius ratio but was independent of Reynolds number and heat flux level. (auth)

33277 FORCED CONVECTIVE ANNULAR-FLOW BOILING WITH LIQUID MERCURY UNDER WETTED AND SWIRL FLOW CONDITIONS. Hsia, E. A. (General Electric Co., Evendale, Ohio). pp 76-83 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

A study to determine the heat transfer mechanism and to correlate the heat transfer data in the annular flow boiling region of mercury was made in a single horizontal tantalum tube with composite helical insert. The mercury parameters were: mass flow rate 81.5 to 192 lb/sec-ft^2, saturation temperature 975 to 1120°F and Reynolds number 0.875 to 2.18×10^4. NaK, a liquid metal, was used as the heating medium. Limited mercury critical heat flux data were also obtained and successfully correlated. The range of variable applicable to the correlation made is tabulated. The experimental technique by which the data were obtained, a description of the test facility, and an estimation of the data accuracy are also included. (auth)

33278 CONVECTIVE BOILING OF A BINARY LIQUID METAL. Mori, Y. (Tokyo Inst. of Tech.); Harada, T.; Uchida, M.; Hara, T. pp 84-9 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

Information about forced convection boiling heat transfer of a binary liquid metal was obtained. The liquid metal used was mercury–bismuth–lead alloy which flowed through a vertical, alloy-steel tube (OD 25.4 mm) heated by radiation using an electric furnace. Measurements were made to determine the axial temperature profile in the liquid, the wall temperatures, and the radial temperature distribution in the two-phase flow. Results indicated that the axial and radial temperature distributions were different from the case of a one component liquid metal and that the heat flux was proportional to the 1.3 power of the temperature difference between the wall surface and the liquid metal. The physico-chemical explanations to these results were resolved using the measured vapor pressure of the liquid metal. (auth)

33279 MECHANISM OF NUCLEATE BOILING HEAT TRANSFER TO ALKALI LIQUID METALS. Deane IV, C. W. (General Electric Co., Cincinnati); Rohsenow, W. M. pp 90-9 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

A model of boiling heat transfer to the alkali liquid metals is postulated from an examination of the events and phases of the nucleate boiling cycle. The model includes the important effect of microlayer evaporation which causes a wave of temperature depression to penetrate into the heating solids; calculated results predict the periodic boiling behavior in the heating solid as a function of the heat flux, the system pressure, the cavity size, and the thermophysical properties of the liquid and the solid. An experimental program was designed to examine the microscale boiling behavior of sodium and to verify the calculated predictions of the boiling model. Artificial cylindrical cavities are used in most of the test sections; a thermocouple is placed close to the boiling surface and adjacent to the cavity wall, and microscale temperature measurements were obtained for stable boiling of sodium from artificial cavities and also from a natural cavity. Horizontal heating surfaces were made from nickel "A," stainless steel 316, and molybdenum-$\frac{1}{2}$%-titanium; the range of saturation pressure is from 20 to 780 mm Hg. Favorable comparisons with the predictions of the boiling model are obtained with data for the bubble period and for the amplitude of temperature oscillation at a thermocouple close to the boiling surface; these results indicate the importance of the microlayer in a model for boiling sodium. (auth)

33280 INFLUENCE ON SUPERHEATING BY SUPPRESSION OF NUCLEATION CAVATIES AND EFFECT OF SURFACE MICROSTRUCTURE ON NUCLEATION SITES. Kottowski, H.; Grass, G. (CCR-EURATON, Ispra, Italy). pp 108-15 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

Superheating measurements in alkali metals show a large scattering. The superheating is closely connected with the formation of boiling nuclei. The probability of the formation of homogeneous boiling nuclei in the liquid itself is very small and the nucleation will take place on wall cavities or impurities in the liquid. The nature of the heating surface, the size and shape of the microcavities determine the nucleation radius and thereby superheating. The influence of the surface microstructure on the superheating is discussed. The experimental results on deactivation of wall cavities by application of the pressure and temperature history method of Chen and Holz are presented. The interdependence of operation time and superheating is examined. (auth)

33281 EFFECTS OF VELOCITY, OXIDE LEVEL, AND FLOW TRANSIENTS ON BOILING INITIATION IN SODIUM. Logan, D.; Baroczy, C. J.; Landoni, J. A.; Morewitz, H. A. (Atomics International, Canoga Park, Calif.). pp 116-28 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

Data are presented for incipient boiling of sodium flowing upward in a 15 in. and 30 in. long vertical annulus formed by a heated stainless steel tube of $\frac{1}{4}$ in. diameter located inside a $\frac{1}{2}$ in. diameter tube. Liquid velocity, heat flux, inlet subcooling, surface condition, and oxide level are investigated for their effect on boiling inception superheat. Existing boiling inception models are examined and a dynamic superheat model, based on dimensional analysis, is presented. Forced convection boiling inception data show much lower superheats than those predicted from the Laplace formula, using observed cavity sizes, or the dynamic model. (auth)

33282 EXPERIMENTAL INVESTIGATION OF INCIPIENT VAPORIZATION OF POTASSIUM IN CONVECTIVE FLOW. Chen, J. C. (Lehigh Univ., Bethlehem, Pa.). pp 129-34 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

Experimental measurements of the incipient-boiling superheat, for potassium in forced-convective flow, were obtained at various deactivation pressures, deactivation temperatures, and boiling pressures over a range of flow rates. Results showed that superheats at low flow rates were reasonably well predicted by the deactivation theory. At higher flow rates, the measured superheats were lower in magnitude. With other variables held constant, superheats were found to decrease with increasing flow rates in a distinct and reproducible manner. (auth)

33283 PRESSURE DROP FOR FORCED CONVECTION FLASHING SODIUM. Fauske, H. K.; Grolmes, M. A. (Argonne National Lab., Ill.). pp 135-43 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

A description and analysis is presented of two-phase pressure drop data obtained for flashing sodium in a circular duct. Subsonic as well as sonic flow conditions were tested and thus the pressure drop data include flow regimes in which both momentum and friction losses are important. Predicted values obtained from a "lumped" type annular flow model are shown to be in good agreement with the measured pressure profiles. Furthermore, the validity of employing equilibrium qualities and Lockhart–Martinelli void fractions in this model was verified experimentally. (auth)

33284 BUBBLE GROWTH MEASUREMENTS IN NON-UNIFORMLY SUPERHEATED SODIUM. Singer, R. M.; Holtz, R. E. (Argonne National Lab., Ill.). pp 144-52 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

Measurements of the vapor growth patterns resulting during the transient boiling of initially static, non-uniformly superheated sodium in a vertical channel are presented and discussed. It is demonstrated that the single slug vapor growth model (in which the entire channel cross-section is filled with vapor except for a thin liquid film on the walls) may not be valid when the liquid temperature gradient normal to the channel axis is large and asymmetric, and/or the incipient boiling superheat is small. Under certain conditions, void fractions as low as 0.3 to 0.5 were observed. When the incipient superheat is large (i.e., when the void fraction is large), the predictions of a simple vapor growth model compare favorably with the measured results. Experimental data on the vapor growth and collapse rates and the associated pressure transients are presented for boiling pressures up to about 1 atm and superheats up to about 180°C. (auth)

33285 NEMI MODEL FOR SODIUM BOILING AND ITS EXPERIMENTAL BASIS. Pezzilli, M.; Sacco, A.; Scarano, G.; Tomassetti, G.; Pinchera, G. C. (Comitato Nazionale per L'-Energia Nucleare, Rome). pp 153-61 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

The NEMI model, whose theoretical assumptions are derived from the analysis of several experiments on sodium boiling, describes the coolant behavior during a flow or power transient of a sodium cooled fast reactor channel, taking into account different boiling patterns. A theoretical study of the influence of velocity on superheat is described. (auth)

33286 STRUCTURE OF A SUBMERGED IMPINGING GAS JET. Bell, R. (Liverpool Inst.); Boyce, B. E.; Collier, J. G. J. Brit. Nucl. Energy Soc.; 11: No. 2, 183-93(Apr 1972).

The results and interpretations are presented of an experimental study of the structure of a gas jet submerged in water and impinging onto a plane or curved surface. This situation may occur in a gas-to-liquid heat exchanger of the shell and tube type, or in the core of a liquid cooled nuclear reactor. The experiments covered the influence of the principal independent variables such as jet diameter, 0.127 – 1.74 mm, jet-to-surface spacing, 1.5 – 7 mm, gas stagnation pressure up 27.6 bar and the effect of a significant water cross-flow, up to 5 m/s. Visual observations showed that water droplets entrained at the outer edges of the jet were deposited on the surface and formed a liquid film which flowed radially outwards under the shearing action of the spreading gas jet immediately above it. A light probe was used to obtain local measurements of void fraction and droplet distribution at various heights above the surface. Conductance probes set in the surface enabled the thickness of the deposited liquid film to be measured. A further experiment was performed to measure directly the diffusion angle of the submerged gas jet and also the total amount of droplet entrainment. The results were used to estimate droplet diameters at various levels above the surface. A semi-empirical relationship was derived between the droplet deposition rate, the thickness of the liquid film on the surface and the interfacial shear stress between the film and the gas layer immediately above. (UK)

33287 LAMINAR AND TURBULENT FORCED CONVECTION HEAT TRANSFER IN A SYMMETRIC TRAPEZOIDAL CHANNEL. Chiranjivi, C.; Sankara Rao, P. S. (Andhra Univ., Waltair, India). Indian J. Technol.; 9: No. 11, 416-20(Nov 1971).

Heat transfer from one side of a symmetric trapezoidal section kept at constant temperature under laminar and turbulent flow conditions was studied. The important parameters allowed to vary were: Prandtl number of the fluid, Reynolds number of the flow and the heat flux of the heated side of the section. The experimental results indicate that Nusselt number is a function of $(\mathrm{Re})^{0.14}$ in the laminar region and $(\mathrm{Re})^{0.4}$ in the turbulent region. Transition takes place at Re = 2100. Prandtl number and the Sieder and Tate viscosity ratio modification to correct the distortion of velocity profile due to non-isothermal conditions across the channel are found to be the correlating parameters with exponents different from those for a circular tube. The experimental data obtained under both laminar and turbulent flow conditions were correlated by a single equation $\mathrm{Nu} = \alpha \mathrm{Re}^{\gamma} \mathrm{Pr}^{0.52} (\mu_s/\mu_{av})^{-0.21}$ where α and γ are functions of Reynolds number. (auth)

33288 THERMAL INSULATION AT HIGH TEMPERATURE. Echigo, Ryozo (Kyushu Univ., Japan); Tanida, Minoru; Shimomura, Hiroaki. Nippon Genshiryoku Gakkaishi; 14: No. 4, 164-9(Apr 1972). (In Japanese).

Studies on thermal insulation at high temperature have been widely performed, stimulated by the development of high temperature gas cooled nuclear reactors. These insulators are often exposed not only to high temperatures but at the same time also to high pressures and, hence, have required elucidation of heat transport mechanisms under such conditions for the purpose of evaluating thermal insulation. Aspects of thermal insulation performance at high temperature and pressure have been reviewed briefly based on the results of recent studies. The fibroid and porous (both permeable and impermeable) materials for insulation (random insulators) are taken up, and the characteristics are discussed by comparisons with multilayer foil insulators (regular insulators) and, further, not only the micro-cell and free convective but also radiative heat transfer in random insulators are discussed in some detail. Also, typical methods for the measurement of the apparent thermal conductivity are outlined and practical applications in nuclear reactors are illustrated, taking as a case study the Fort St. Vrain Cooled Reactor. (auth)

33289 HEAT TRANSFER: MINNEAPOLIS. ASME-AIChE 11th National Heat Transfer Conference, Held in Minneapolis, Minnesota, August 3–6, 1969. Hsu, Y. Y. (ed.). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 1-221(1970). (CONF-690845).

Twenty papers selected from the conference are included here. A separate abstract was prepared for each of the eight papers selected as being in scope for NSA. (J.R.D.)

For abstracts of individual papers see: 33290—33296, and 34763.

33290 PRESSURE WAVE PROPAGATION IN TWO-PHASE MIXTURES. Henry, R. E. (Lewis Research Center, Cleveland). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 1-10(1970).

From eleventh national heat transfer conference; Minneapolis, Minn. (3 Aug 1969).

The mechanism for interphase momentum transfer during the propagation of an infinitesimal pressure pulse through a bubble-like ($\alpha \leq 0.50$) two-phase mixture is investigated analytically, and the result indicates that the effects of heat and momentum transfer may be correlated as a function of void fraction. A correlation for the propagation velocity is developed from air-water data, which had a system pressure of 25 lb./sq. in. abs., and it is compared with air-water and steam-water results for pressure levels ranging from 10 to 285 lb./sq. in. abs. The good agreement substantiates the analytical development. The importance of the mixing technique with regards to the temporal and spacial uniformity of the flow is discussed, and the experimental data are shown to be in agreement with the expected trends. A short discussion of the essential differences between the two-phase propagation velocity of an infinitesimal pulse and that of a sound wave is also included. (auth)

33291 CONDENSING HEAT TRANSFER CONSIDERATIONS RELEVANT TO RUBIDIUM AND OTHER ALKALI METALS. Sartor, Anthony J.; Balzhiser, Richard E.; Barry, Robert E. (Univ. o of Michigan, Ann Arbor). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 26-36(1970).

From eleventh national heat transfer conference; Minneapolis, Minn. (3 Aug 1969).

Results of investigations of anomalies which exist in the data for liquid metal condensation are presented. Results are also presented on interfacial heat transfer resistance for condensing Rb. Information and discussions are included on film theory of condensation, effects of noncondensibles, experimental equipment and procedures, and results. It is proposed that the departure from Nusselts theory noted in alkali metal condensation may be attributed to resistance in the vapor phase as postulated by the kinetic theory of condensation. (J.R.D.)

33292 NONEQUILIBRIUM BUBBLE COLLAPSE: A THEORETICAL STUDY. Theofanous, T. G.; Biasi, Luigi; Isbin, H. S.; Fauske, H. K. (Univ. of Minnesota, Minneapolis). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 37-47(1970).

From eleventh national heat transfer conference; Minneapolis, Minn. (3 Aug 1969).

The dynamics of a single vapor bubble in an infinite volume of incompressible liquid are examined. The use of an approximate solution to the energy equation of the liquid is shown to satisfy most requirements. The theoretical results are discussed in areas such as finite rate of phase change, vapor saturation, mass continuity at bubble walls, subcooling mechanisms, and liquid pressures. Theoretical and experimental results are compared. (J.R.D.)

33293 HEAT TRANSFER IN SPRAY COLUMNS. Markowitz, Avram; Bergles, A. E. (Raytheon Co., Bedford, Mass.). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 63-71(1970).

From eleventh national heat transfer conference; Minneapolis, Minn. (3 Aug 1969).

A fundamental experimental investigation of heat transfer in a spray column has confirmed the existence of a unique transfer mechanism. It has been shown that the heat transfer from the dispersed to the continuous fluid in the column occurs primarily through the drop wake. This mechanism accounts for the severe end effects encountered by previous investigators of liquid-liquid, direct contact heat exchange, and it is this mechanism which accounts for the inability of the solid sphere, heat transfer correlations to predict the spray column behavior. (auth)

33294 PERFORMANCE OF A SODIUM HEAT PIPE. McSweeney, T. I. (Battelle-Northwest, Richland, Wash.). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 72-81(1970).

From eleventh national heat transfer conference; Minneapolis, Minn. (3 Aug 1969).

The operational characteristics of a sodium heat pipe having a wick structure consisting of wire wrapped rods was investigated. Although better flow characteristics are potentially possible with such a wick, the dry out limit was below the expected dry out limit based on current theories. Possible reasons for this difference are discussed. A large temperature gradient, accompanied by oscillations in temperature and heat removal rates, was observed when the cooling coils were very short. [Although this is similar to the description of heat pipe start-up problems reported by other investigators, noncondensables, which were present, could be causing the decreased performance.] Premature dry out was observed when large increases in power were taken, but wick recovery was also shown. A thermocouple, placed in vapor space between evaporator and condenser, was found to be a very sensitive dry out indicator. (auth)

33295 VAPORIZATION HEAT TRANSFER IN CAPILLARY WICK STRUCTURES. Ferrell, J. K.; Alleavitch, Jack (North Carolina State Univ., Raleigh). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 82-91(1970).

From eleventh national heat transfer conference; Minneapolis, Minn. (3 Aug 1969).

The mechanisms of vaporization heat transfer from wick-covered heated surfaces were studied. It was found that for values of the heat flux below the critical, the mechanism of vaporization heat transfer from wick covered surfaces is one of conduction across a thin, liquid saturated film in contact with the heated surface, which is maintained by the capillary forces existing at a liquid-vapor interface within the wick. The liquid-vapor interface appeared to be located at the minimum pore diameter in the first layer of particles on the surface and resulted in a nearly constant heat transfer coefficient. This makes the concept of a heat transfer coefficient much more useful than in ordinary pool boiling. A maximum operable heat flux (critical heat flux) was reached when the capillary forces were no longer sufficient to maintain a liquid saturated film at the heated surface. For wick materials which are in contact with the heated surface, and whose properties can be characterized by known values of porosity, capillary rise, and permeability, both the heat transfer coefficient and the critical heat flux can be predicted by methods outlined. (auth)

33296 INTERPRETATION OF HORIZONTAL IN-TUBE CONDENSATION HEAT TRANSFER CORRELATIONS WITH A TWO-PHASE FLOW REGIME MAP. Bell, K. J.; Taborek, Jerry; Fenoglio, Frank (Heat Transfer Research, Inc., Alhambra, Calif.). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 150-63(1970). (1970).

From eleventh national heat transfer conference; Minneapolis, Minn. (3 Aug 1969).

The use of correlations for predicting filmwise condensation of a pure component inside a horizontal cylindrical tube is described. Methods are discussed which are used to establish a link between the various correlations and their proper interpretation in terms of flow regime structure, which, in turn, determines the probable range of validity. Typical literature methods for predicting heat transfer coefficients for in-tube condensation are evaluated, and the two-phase flow regimes for which each correlation is probably valid are identified. The trends of prediction for six representative correlations are compared and procedure for selecting a correlation for a given application is suggested. Suggestions for future direction of research in the condensation field are included. (J.R.D.)

Materials Testing

Refer also to abstracts 33266, 33400, 33845, and 33989.

33297 (ARL/MET-N-75) CONSIDERATION OF THREE MODERN NONDESTRUCTIVE TEST TECHNIQUES. Scott, I. G. (Aeronautical Research Labs., Melbourne (Australia)). Jun 1971. 16p. INIS.

Studies were made of three possible techniques suitable for use in NDT, namely—the transducerless generation of ultrasound, the use of radioactive gas, and microwave testing. The first is in the very early stages of development, the second has been shown to be relatively successful but requires equipment which is not readily available at Aeronautical Research Laboratories, and the third method is limited to the use with non-conducting materials. (auth)

33298 (CEA-CONF-1977) OPTIMIZATION OF THE POSITION OF THE TRANSDUCERS IN THE ULTRASONIC TESTING OF THIN TUBING. Perdijon, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct 1971. 22p. (In French). (CONF-711136-1). Dep. NTIS (U. S. Sales Only).

From Meeting on nondestructive testing in the manufacture and utilization of steel tubes; Paris, France (9 Nov 1971).

The ultrasonic testing of the canning of nuclear fuels has necessitated the development of special equipment, and the establishment of a method, which is generally more applicable to thin tubes. The method of testing involving Lamb waves is briefly discussed. A machine is described which enables the tubes to be inspected at a rate of between 1 and 4 meters per minute. A method is then described for optimizing the position of the transducers. The best control obtained for 0.45mm thick stainless steel tubing and for 4MHz transducers is defined. A method is indicated for distinguishing internal faults from external faults. (France)

33299 (HSST-TR-17) THREE-DIMENSIONAL ELASTIC-PLASTIC ANALYSIS FOR FRACTURE MECHANICS. PHASE II: IMPROVED MODELING. Levy, N.; Marcal, P. V. (Brown Univ., Providence, R. I. Div. of Engineering). 1 Nov 1971. Contract W-7405-eng-26. 48p. Dep. NTIS.

The use of finite element analysis for three-dimensional problems is described. Improved finite element meshes are used to study the flawed tensile specimen with both elastic perfectly plastic and strain hardening material. Solutions were obtained with idealizations and with 4500 degrees of freedom. It was found that strain hardening had little effect below the corresponding limit load for a perfectly plastic material specimen. At higher loads significant increases in strain rates were observed. However constraint effects as defined by stress ratios were found to be constant. (auth)

33300 (ORNL-TM-1312(Vol.12)) STRUCTURAL ANALYSIS OF SHIPPING CASKS. VOLUME 12. ENERGY ABSORPTION CHARACTERISTICS OF STAINLESS STEEL BOLTS UNDER IMPACT LOADING. Cannon, D. D. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 114p. Dep. NTIS. Thesis. Submitted to Univ. of Tennessee, Knoxville.

The behavior of stainless steel bolts under impact loading representative of that experienced by shipping casks subjected to accident conditions was studied in order to determine the energy absorption characteristics, the fracture elongation, and the peak force developed in these bolts under specified impact conditions. This information is needed by the designers and analysts of shipping casks for radioactive materials to assure the safety of the public. A survey of the published technical literature revealed very little information on the plastic behavior of stainless steel bolts under impact loading in the range of impact velocities applicable to shipping casks, and an experimental program was undertaken to develop the needed information. Coarse-threaded bolts made of type 304 stainless steel by three manufacturing processes were impacted by free falling weights dropped from known heights. The specimens tested included both bolts with full-diameter shanks and bolts with their shanks reduced to various shank-area-to-tensile-stress-(threaded) area ratios to determine the optimum stress area ratio that will result in the maximum amount of absorbed energy. The force applied during each impact event was measured and recorded as a function of time by using load cells instrumented with resistance strain gage bridges, signal conditioning equipment, an oscilloscope, and a Polaroid camera. A digital computer program was prepared to convert the force-time data to acceleration-time data and numerically integrate the acceleration-time data to yield velocity-time and displacement-time data. The force-displacement data were then integrated to determine the amount of energy absorbed. The optimum stress area ratio for cold-forged type 304 stainless steel bolts with rolled threads and strain-hardened hot-forged type 304 stainless steel bolts with ground threads is illustrated graphically in plots of the absorbed energy and fracture elongation as a function of the stress area ratio. The energy absorption capability and fracture elongation are plotted as a function of bolt geometry for hot-forged type 304 stainless steel bolts in both the strain hardened condition with ground threads and the as-forged condition with machine-cut threads. The energy absorption capability of cold-forged type 304 stainless steel bolts with rolled threads is given for three bolt sizes. Typical dynamic peak force values experienced by bolts with diameters of 3/8, 1/2, 5/8, 3/4, and 1 inch are given. When stainless steel bolts of the same material conditions and sizes tested are used in shipping cask closures, the test data presented herein can be used to predict the energy absorption capacity, fracture elongation, and the peak force experienced by these bolts when they are subjected to the impact loading resulting from a 30-foot free fall of the cask onto an essentially unyielding surface. (auth)

33301 (PNC-N-831-70-2, pp 59-64) NONDESTRUCTIVE TESTING OF FBR WRAPPER TUBE. Koyama, Buei; Watanabe, Takuro; Tateishi, Yoshinori; Aoki, Toshimasa (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-7).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Wrapper tubes are one of the FBR fuel assembly components. Wall thickness of the wrapper tubes was measured at both ends with a micrometer, but it is difficult to measure the wall thickness of other than the ends with the micrometer. The measurement of wall thickness of wrapper tubes over full length by the following methods is described: ultrasonic resonance method and SMD (sony magneto diode) method. In the ultrasonic method there are two methods, one is immersion method and the other is direct contact method. Because of difficulty in focussing the ultrasonic beam on the wall over the full length of the wrapper tubes by the immersion method, the direct contact method was used. Moreover, because material of the wrapper tubes was non-magnetic, the magnetic method was used. Results of these two methods are compared with results of the micrometer method. (Japan)

33302 (PNE-RB-24) EXHIBITS: INFORMAL PUBLIC HEARINGS ON PROJECT RIO BLANCO (DENVER, COLORADO). (Atomic Energy Commission, Washington, D. C.). 27 Mar 1972. 250p. Dep. NTIS.

The exhibits presented at the informal public hearings held on Mar. 27 and 28, 1972 at Denver, Colo. to receive comments concerning the Rio Blanco Event are compiled. These exhibits include: statements by Oil Shale Corp. officials; reports on seismic effects of the proposed Rio Blanco Event; an article on the seismic effects of underground nuclear explosions published in the Bulletin of the Seismological Society of America; report from

Governor's Advisory Committee on Rio Blanco Event; and appendixes on natural gas and shale oil resources, predicted seismic effects, geologic characteristics of the Rio Blanco site, statements by Oil Shale Corp. and state geologists, individuals, representatives of groups concerned with protection of the environment, and officials of gas and petroleum companies. (L.C.L.)

33303 STRESS CONCENTRATION APPROACH TO FRACTURE MECHANICS. Irvine, W. H.; Quirk, A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 76-84 of Practical Application of Fracture Mechanics to Pressure-Vessel Technology. London; Institution of Mechanical Engineers (1971).

From Conference on practical application of fracture mechanics to pressure-vessel technology; London, England (3 May 1971). See CONF-710534.

A stress concentration approach to define the instability criterion of a stressed material containing a through thickness defect is described. The approach basically depends on simple considerations of static equilibrium in the plane of the crack. It is shown that the basic equation satisfies fracture data for widely varying materials. By postulating that failure at the crack tip occurs at a constant failure stress which is a basic material property and is proportional to the ultimate tensile strength in uniaxial tension, an equation is derived which gives the critical crack length in terms of nominal stress level, Charpy V energy, and conventional tensile properties. (auth)

33304 RADIATION SAFETY IN THE USE OF γ-DEFECTOSCOPIC APPARATUSES. Lyarskii, P. P.; Korenkov, I. P.; Moiseitsev, P. I.; Pertsov, V. A. Gig. Sanit.; No. 11, 49-52 (Nov 1971). (In Russian).

The peculiar radiation features, the irradiation hazards to operating personnel, and means of protecting the operators of γ-defectoscopes of various types and purposes are discussed. It was found that when all the requirements of radiation safety regulations are fulfilled the irradiation level of the defectoscope operators, as a rule, is within the limits of permissible levels and, at the present time, does not exceed 1 to 2.5 r/yr in ambulant and 0.2 to 0.3 r/yr in stationary γ-defectoscopy. (auth)

33305 PREPARATION OF SINGLE-STAGE CARBON EXTRACTION REPLICAS FROM NEAR THE EDGE OF A SECTIONED SPECIMEN. Stumpf, Waldo E. (Atomic Energy Board, Pretoria). Prakt. Metallog.; 9: No. 3, 166-9(Mar 1972). (In German and English).

A technique was developed by which the carburized zones on metal specimens can be examined by single-stage extraction replicas. The specimens used included chromium steel, Incoloy 800, and Inconel 718 exposed to UC powder at 600 to 800°C. Optical microscopy did not reveal any signs of an interaction with the UC although a decrease of 13% in the room temperature tensile strength did indicate some incompatibility effects. It was found that a dense niobium-containing M_6C precipitate had formed near the surface at the expense of the fine strengthening phase which has a bct structure with composition $Ni_3(NbAlTi)$. Secondly, it is clear that the normal transformation of the metastable bct-γ' phase to the disc-like stable Ni_3Nb phase is retarded near the edge of the specimen. (J.R.D.)

33306 METHOD FOR STUDYING THE DISTRIBUTION OF URANIUM IN A Mg—Be FUEL JACKET. Gorenko, A. F.; Shevchenko, G. M.; Bugaeva, N. I.; (and others). At. Energ. (USSR); 32: No. 3, 231-2(Mar 1972). (In Russian).

Mutual diffusion has been observed at the area of contact of fuel and jacket during reactor operation. The resulting U distribution in a Mg—Be jacket 500 to 600 μ thick was studied using fuel rods of natural U by stepwise HNO_3 dissolution of the jacket. Fifteen layers were thus removed by dissolution and individually extracted using 20% TBP in CCl_4 in order to isolate and measure the U. The results indicate that the method described is capable of revealing the U distribution in a fuel jacket. (K.S.W.)

33307 ELECTRONIC PROCESSING SYSTEM FOR DATA FROM POST-IRRADIATION EXAMINATION OF FUEL ELEMENTS. Olshausen, K. D. (Institutt for Atomenergi, Kjeller, Norway). Atomkernenergie; 19: No. 3, 241-4(May 1972).

A system for recording and processing of data obtained during the post-irradiation examination of irradiated fuel pins is described. An incremental magnetic tape recorder is used for the recording of data from dimensional measurements and gamma scanning. The system can be adapted for other purposes as for example the recording of stress—strain curves obtained during tensile testing on an Instron-machine. Examples of computer outputs (curves and tables) are given. (auth)

Nuclear Explosions

Refer also to abstracts 33340, 33341, 33363, and 33536.

33308 (AD—707084) PRESSURE EQUILIBRATION AROUND EJECTA IN A NUCLEAR SURFACE BURST. Final Report. Trulio, John G.; Glenn, Lewis A. (Applied Theory, Inc., Santa Monica, Calif.). Jun 1970. Contract DASA01-68-C-0098. 53p. (ATR—70-14-6; DASA—2457). NTIS.

In order to simulate the equilibration of air blast overpressure around an ascent ejecta fragment in a nuclear surface burst, calculations were made of impulsive viscous flow of a polytropic gas into an L-shaped crack. (GRA)

33309 (AD—734838) MEADS FOR NUCLEAR WEAPON SYSTEMS. Lavery, John V. Jr.; Slyker, Charles E. (Picatinny Arsenal, Dover, N. J.). Oct 1971. 118p. (PA-TM—2025). NTIS.

The work that has been completed in the development of a Maintenance Engineering Analysis Data System (MEADS) for nuclear weapon systems is summarized. The discussion proceeds from general background on MEADS to the very specific details required for implementation of this automated system. The MEADS for nuclear weapons as presented differs slightly from that presented in TM38-703-3, MEADS, due to the particular needs and objectives of nuclear weapons. The information presented is useful to other activities that are implementing a similar system. (auth) (NTIS)

33310 (BMI—171-144) AMCHITKA BIOENVIRONMENTAL PROGRAM. RESEARCH PROGRAM ON MARINE ECOLOGY, AMCHITKA ISLAND, ALASKA. Annual Progress Report, July 1, 1970—June 30, 1971. Burgner, R. L.; Nakatani, R. E. (Washington Univ., Seattle. Fisheries Research Inst.). Mar 1972. Contract AT(26-1)-171. 79p. Dep. NTIS.

For Battelle Columbus Labs., Ohio.

Research on the marine environment of Amchitka Island continued to evaluate the effects of Milrow (October 2, 1969) and to initiate preevent studies for Cannikin (FY 1972) at Site C. The features studied included fish, invertebrates, algae, and sea otter stomach analyses. Marine sampling was conducted for radiological analysis. No effects of Milrow on nearshore fishes were observed. Exploratory fishing in the surface zero (SZ) vicinity revealed a predominance of juvenile offshore fishes not previously seen. No Pacific ocean perch were located in areas found previously to have abundances of this species. During the fall season nearshore fishes off the Bering Sea side of SZ were not as numerous as those in more protected bays. Additional diet studies are reported. Preliminary succession studies on rock falls produced by Milrow indicate that in one year these new rocks were colonized much like pre-Milrow rocks of similar location. Siltation of the intertidal bench below the Square Bay rock slide is smothering a small area. Algal studies at several locations are discussed. (auth)

33311 (CNEN-Doc-DAISE—71-9) PEACEFUL NUCLEAR EXPLOSIONS. Calori, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 35p. (In Italian). INIS.

After a short introduction, main applications of this technique to civil engineering are described. In the field of underground engineering, possible uses of nuclear weapons for obtaining deflagrations allowing the exploitation of materials occurring in deposits which are not economic from a conventional standpoint, are pointed out. The construction of dams, harbors and canals by this technique is also dealt with. The hazards related to a nuclear explosion and the problems involved are exposed. Main activities and programs of countries interested in this kind of research according to official statements are outlined. A short conclusion describes the state-of-the-art as to the 1 January 1971, date of the last Panel on the subject held in Vienna. (auth)

33312 (EERO-TR—33) PROJECT SERGIUS NARROWS: SUMMARY OF TESTS ON LIESNOI ISLAND, ALASKA, 1970. Gillespie, Richard H. (Army Engineer Explosive Excavation Research Office, Livermore, Calif.). Nov 1971. 49p. Dep. NTIS.

Project Sergius Narrows was executed during the period 8 June through 8 July 1970 in a granitic medium on Leisnoi Island, Alaska. The tests consisted of attempts (1) to spring (enlarge) 57 small-diameter drill holes to accept cratering charges, and (2) to detonate successfully as cratering charges the holes sprung. The tests indicated that hole springing in an intermediate-to-high-strength rock is not economical due to the high probability of hole collapse. The cratering results are sketchy but tend to indicate that the cratering criteria developed for high-strength rock are valid for the granitic medium of Sergius Narrows, Alaska. (auth)

33313 (FOA-4-4455) LINEAR MODEL FOR THE YIELD DEPENDENCE OF MAGNITUDES MEASURED BY A SEISMOGRAPHIC NETWORK. Ericsson, Ulf (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Feb 1971. 40p. Dep. NTIS (U. S. Sales Only).

The connection between the yield of six underground nuclear explosions in the Pahute Mesa in Nevada and the body and surface wave magnitudes measured at 19 Canadian seismographic stations is described by a simple statistical model. It describes the expected magnitude as a linear function of the logarithm of the yield and attributes the apparently normally distributed magnitude variations between stations to wave path dependent level differences between the transfer functions from the source area to the stations. The model assigns the same scaling exponent for yield to all stations. The exponent is, however, larger for surface wave magnitudes than for body wave magnitudes. The station residuals are partly attributed to differences, between explosions, in the energy coupling in the source area. The residuals are roughly normally distributed and the stations can be divided into groups with high and low residual variances. Applications of the model to the prediction of station magnitudes from given yields, to the calculation of maximum likelihood estimates of yields from measured station magnitudes and to the identification of underground nuclear explosions by simultaneous measurements of body and surface wave magnitudes are briefly discussed. (auth) (Sweden)

33314 (JAB-99-89) OBSERVED DYNAMIC RESPONSE CHARACTERISTICS OF RESIDENTIAL STRUCTURES: PROJECT TRINIDAD. Scholl, R. E.; Farhoomand, I. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). May 1972. Contract AT(26-1)-99. 48p. Dep. NTIS.

Observed dynamic response characteristics for a series of residential structures tested at Sopris, Colorado, in November 1970 are summarized. Four houses and a free-standing chimney were dynamically tested to determine their frequency, damping, and mode shape characteristics. The house vibration characteristics measured are primarily building-as-a-unit motion. Some response observations for chimneys associated with two of the houses are also reported. (auth)

33315 (PNE-714-F) WEATHER PREDICTIONS AND SURFACE RADIATION ESTIMATES FOR THE SULKY EVENT. Final Report. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Air Resources Lab.). Mar 1972. Contract SF-54-351. 39p. Dep. NTIS.

The activities performed by the Weather Bureau Research Station, Las Vegas, Nevada in support of Project Sulky are described. The objectives and functions of the Weather Bureau in the Sulky experiment are outlined. The meteorological facilities and procedures are discussed along with the meteorological forecasts and radiation estimates which were issued. These forecasts are compared with meteorological and radiological data collected during and after the detonation of Sulky. The post-shot meteorological trajectories are described and the results of a tetroon tracking experiment run in conjunction with the Sulky shot are presented. (auth)

33316 (PNE-1118) PROJECT PRE-GONDOLA III PHASE II: MICROBAROGRAPH MEASUREMENTS. Reed, Jack W. (Sandia Labs., Albuquerque, N. Mex.). Jun 1971. 18p. Dep. NTIS.

Four microbarograph stations recorded waves at a range of approximately 130 miles from a row charge of high explosives buried near optimum cratering depth. Comparison with propagations from three airburst calibration detonations showed that a source model derived from close-in data was appropriate for distant effects predictions. This model predicted that wave amplitudes from explosives at this scaled depth would be 20% of amplitudes expected for a free-air burst. All amplitudes perpendicular to a row charge are proportional to the 0.7 power of the number of charges in the row. (auth)

33317 (PNE-RB-18(Vol.3)) PROJECT RIO BLANCO DEFINITION PLAN. VOLUME III. REENTRY-RELATED DETAILED TASKS. (CER Geonuclear Corp., Las Vegas, Nev.). 28 Feb 1972. 120p. Dep. NTIS.

Rio Blanco is a proposed experiment in which three underground nuclear explosions are to be simultaneously detonated at different depths in the Piceance Basin in Colorado to demonstrate the commercial feasibility of using underground nuclear explosions to stimulate production from natural gas reservoirs. Activities related to the reentry phase of Rio Blanco Project are described in detail and include: general site activities; reentry program; production testing; operational safety; environmental protection program; public relations, and time scheduling of individual tasks. (L.C.L.)

33318 (PNE-RB-21) TRANSCRIPT: INFORMAL PUBLIC HEARINGS ON PROJECT RIO BLANCO (MEEKER, COLORADO). (Atomic Energy Commission, Washington, D. C.). 24 Mar 1972. 126p. Dep. NTIS.

The complete transcript is presented of an informal hearing which was held on Mar. 24, 1972 at Meeker, Colo. to receive public comments concerning the Draft Environmental Statement on the Rio Blanco Gas Stimulation Project. Thirteen witnesses presented comments. (L.C.L.)

33319 (PNE-RB-22) EXHIBITS: INFORMAL PUBLIC HEARINGS ON PROJECT RIO BLANCO (MEEKER, COLORADO). (Atomic Energy Commission, Washington, D. C.). 24 Mar 1972. 125p. Dep. NTIS.

The exhibits presented at the informal public hearing held on Mar. 24, 1972 at Meeker, Colo. to receive public comments concerning the Rio Blanco Event are compiled. These exhibits include: a report on the hypothetic exposure rates from commercial use of Rulison-stimulated natural gas; a statement from a geologist on natural gas supply and demand; statements by individuals representing environmentalists, woolgrowers, area residents, businessmen, and local city officials; and newspaper articles about the Rio Blanco project. (L.C.L.)

33320 (PNE-RB-23) TRANSCRIPT: INFORMAL PUBLIC HEARINGS ON PROJECT RIO BLANCO (DENVER, COLORADO). (Atomic Energy Commission, Washington, D. C.). 27 Mar 1972. 219p. Dep. NTIS.

The complete transcript is presented of informal hearings held on Mar. 27 and 28, 1972 at Denver, Colo. to receive public comments concerning the Draft Environmental Statement on the Rio Blanco Gas Stimulation Project. Twenty-four witnesses presented comments. (L.C.L.)

33321 (UCRL-73747) ANALYSIS OF NUCLEAR GAS STIMULATION. Werth, G. C.; Rubin, B.; Schwartz, L.; Montan, D. (California Univ., Livermore. Lawrence Livermore Lab.). 16 Feb 1972. 27p. (CONF-720205-1). Dep. NTIS.

From seventy-first national meeting of the American Institute of Chemical Engineers; Dallas, Tx. (20 Feb 1972).

An economic analysis of nuclear gas stimulation is presented using data from the Gasbuggy and Rulison Events which have been fired successfully and information related to the proposed experiments, Rio Blanco in Colorado and Wagon Wheel in Wyoming. The commercial development of natural gas reservoirs using nuclear stimulation is discussed in terms of: future natural gas requirements in the US; expected production; well costs; seismic and radiological safety requirements; rate of return on investment; possible alternative to increasing gas supplies; and cost of such alternatives. (L.C.L.)

33322 NON PROLIFERATION TREATY. Zijp, Willem L. (Reactor Centrum Nederland, Petten). Atoomenergie Haar Toepass.; 14: 9-17(Jan 1972). (In Dutch).

After a short introduction of the Non Proliferation Treaty (NPT) a description is given of the structure and contents of the draft agreement between UN-member states on one side and the IAEA in Vienna on the other side. In particular attention is given to the meaning, the principles and the rules for inspection, as laid down in the draft agreement. (auth) (Netherlands)

Protective Structures and Equipment

Refer also to abstracts 33534, 33562, and 33564.

33323 (AD-706238) DIFFUSION OF FALLOUT SHELTER INNOVATIONS. A STUDY OF PUBLIC AND HOME FALLOUT SHELTER ADOPTION IN THE U. S. A., 1964, 1966, 1968. Final Report. Klonglan, Gerald E.; Yarbrough, Paul; Lutz, Gene M. (Iowa State Univ. of Science and Technology, Ames. Dept. of Sociology and Anthropology). Feb 1970. Contract DAHC20-69-C-0103. 124p. NTIS.

The U.S. population's adoption and diffusion of public and home fallout shelter innovations is analyzed. The analysis is based on data collected in the 1968 National Civil Defense Study and compared to the 1966 and 1964 national studies, each sampling 1500 respondents. (auth) (GRA)

33324 (MLM-1892) RESPIRATORY DEVICE PROGRAM AT MOUND LABORATORY. Musen, L. G. (Mound Lab., Miamisburg, Ohio). 25 Apr 1972. Contract AT(33-1)-Gen-53. 29p. Dep. NTIS.

The primary objective of the respiratory program is to prevent the inhalation of radioactive material. When the disbursement of radioactive material becomes a possibility because the process or operation cannot be contained completely or because of a system failure, then respiratory protection is mandatory. It is, however, more desirable to have all processes contained thus limiting the need for respiratory protection from radioactive, chemical, or dust toxic agents. Most problems can be overcome by a good program even with personal difficulties in the use of the respirators. It has been found that a thorough orientation program, a good fit of the respiratory device, and the proper use of the device aid considerably in the overall radiological protection program. (auth)

33325 (PNC-N-831-70-2, pp 85-8) MASK TEST IN PNC. Higuma, Takanobu; Asano, Takashi; Kinoshita, Mutsumi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700227-1).

From fifth annual meeting of Japan Health Physics Society; Tokai, Japan (9 Feb 1970).

An outline of the purpose, method, and results of the Mask Test is presented. The mask test is classified into two tests. One is a "periodic test"; the other is an "at-scene test". In the periodic test, a man wearing a mask is placed in a test chamber containing an appropriate concentration of DOP aerosol. In order to obtain air sample from inside of the half-face mask, a funnel with a tube is connected to the mask. Ratio of the concentration of DOP inside the mask and that of the test chamber represents amount of leakage. 71 men wearing the half-face mask were tested and the average leak rate was 3.99%. Those with more than 1% leakage were given instructions in the proper wearing of the mask and their masks were changed. Then the average leak rate became 0.5%. 17 men were tested with a MSA's full-face mask. All men had less than 1% leak rate; the average was 0.3%. The at-scene test is a good method for quickly checking fitness of respirators. Irritative stannous chloride smoke was introduced around the masks. When the masks were fitted improperly the wearers were irritated and began to cough. In this method the detectable limit of the leakage was 3%. In conclusion, the full-face mask is superior to the half-face one. The "at-scene test" is not the best method for testing gas masks. (Japan)

33326 COMMENTS ON SHIELDING BY THE LEAD SHOT METHOD. Maruyama, Y.; Wrede, D.; Van Arsdale, E.; Sayeg, J.; Engels, E. P. (Univ. of Kentucky Medical Center, Lexington). Radiology; 102: No. 2, 445(Feb 1972).

Mixing several sizes of lead shot increases the shot density. This increased density should be useful for shielding problems in mantle and irregular-field therapy. (auth)

33327 MANIPULATOR APPARATUS. (to Westinghouse Electric Corp.). British Patent 1,273,096. 3 May 1972. Priority date 30 Oct 1969, United States.

A control system for a manipulator assembly having a plurality of jointed arm sections, a last of which carries a terminal device, and a plurality of actuators each responsive to an input signal for effecting relative pivotal movement between the arm sections, characterized in that the system includes means for commanding one of the actuators to move the first of the arm sections, and means responsive to the positional orientation of the commanded arm section for providing output signals to the remaining actuators for moving the remaining arm sections as a function of positional orientation. (J.R.D.)

Safety Engineering

Refer also to abstracts 33304 and 35417.

Vacuum Engineering

Refer also to abstracts 33921 and 35246.

ENVIRONMENTAL AND EARTH SCIENCES

33328 GENEVA 1971. DEVELOPMENT OF ATOMIC ENERGY AND THE ENVIRONMENT. Caron, M. Energ. Nucl. (Paris); 13: No. 6, 421-7(Nov-Dec 1971). (In French).

After recalling the various unfavorable reactions to the development of atomic energy which have occurred in different countries, the measures necessary to obtain objective information about public opinion are enumerated. The comparative advantages of nuclear energy and the problems associated are discussed: safety problems; atmospheric pollution; river pollution by effluents, thermal pollution; storing of wastes; and incidents and accidents. (France)

Minerals and Ores

Refer also to abstract 33335.

33329 (AAEC/LIB/Bib-341) RADIUM: ITS REMOVAL FROM URANIUM MILL EFFLUENTS. A Bibliography. Literature Search Covers the Period 1948-1970. Newland, E. A. (comp.) (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar 1972. 10p. Dep. NTIS (U. S. Sales Only).

Two hundred and seventeen references are listed covering the period 1962 to 1971. Reference to an abstract is made for each citation. The citations are listed alphabetically by author within each year. (Australia)

33330 (GSCan-P-70-52) RADIOACTIVITY IN WESTERN CANADIAN COALS. Cameron, A. R.; Birmingham, T. F. (Geological Survey of Canada, Ottawa (Ontario)). 1970. 40p. INIS.

Significant concentrations of U have been found in Cretaceous and younger coals and carbonaceous shales in the mid-western United States. Field and laboratory data obtained during a study of lignite and other Tertiary coals of western Canada are presented. The Cypress Hills area of Saskatchewan holds the best promise for commercial concentrations of uranium. (auth) (INIS)

33331 ^{236}U/^{238}U MEASUREMENTS IN THREE TERRESTRIAL MINERALS AND ONE PROCESSED ORE. Rokop, D. J.; Metta, D. N.; Stevens, C. M. (Argonne National Lab., Ill.). J. Mass Spectrom. Ion Phys.; 8: No. 4, 259-64(Apr 1972).

The ^{236}U/^{238}U ratio was measured mass spectrometrically in the following terrestrial uranium samples: uraninite with $(2.3 \pm 0.8) \times 10^{-10}$; schroeckingerite with $(2.0 \pm 2.0) \times 10^{-10}$; thucholite with $(0.8 \pm 1.5) \times 10^{-10}$; and a processed ore with $(6.2 \pm 2.2) \times 10^{-10}$. (auth)

33332 REGULARITIES IN THE DISTRIBUTION OF ELEMENTS ASSOCIATED WITH URANIUM IN DEPOSITS OF RARE METALS. Solov'ev, N. N.; Strelkina, E. M. (Moscow Geological Prospecting Inst.). Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; 14: No. 1, 35-40(1971). (In Russian).

The chemical elements Pb, V, Cu, Au, As, and Tl form aureoles dispersed about uranium ore bodies. The logarithms of the ratios Pb/U and V/U form a greatly contrasted pattern of zonality and are employed as indicators. In general the character of correlating bonds alters less definitely with depth as compared with the logarithms of the ratios Pb/U and V/U. Lead, and to a lesser extent niobium, enter into the composition of the ore-forming mineral. Vanadium is noted as an admixture in carbonate metasomatites. The chief ore-forming element, U, and its satellite elements, Pb and V, are direct indicators of mineralization. (K.S.W.)

33333 FISSION-FRAGMENT TRACKS IN APATITE: RECORDABLE TRACK LENGTHS. Bhandari, N.; Bhat, S. G.; Lal, D.; (and others) (Tata Inst. of Fundamental Research, Bombay). Earth Planet. Sci. Lett.; 13: No. 1, 191-9(Dec 1971).

This study is concerned with the measurements of total lengths of fission-fragment tracks due to spontaneous fission of ^{238}U (fossil tracks) and neutron-induced fission of ^{235}U (n-induced tracks) in several terrestrial apatites of geological age exceeding 0.4 billion years. The measurements of total etchable lengths are based on the revelation of confined tracks, TINTs and TINCLEs. The mean etchable length of confined n-induced tracks in fluor- and hydroxyl-apatites is measured to be $15.3 \pm 1\ \mu$; the longest tracks are about $18\ \mu$ in length. The length distribution of confined natural fossil tracks shows a wider but peaked distribution; the position of peak is shifted to lower lengths as compared to that for n-induced tracks. Thus measurable annealing effects are found in old apatites for the stored fission tracks. The measurements of TINTs and TINCLEs in apatites allow an estimation of the correction needed for annealing effects in fission-tracks ages. (auth)

Radioactive Effluents

Refer also to abstracts 35458, 35514, 35515, 35538, 35544, and 35602.

33334 RADIOACTIVE EMISSIONS BY COAL-FED POWER STATIONS. Marquardt, W.; Hoehle, R.; Schuh, U. (Institut fuer Energetik, Leipzig. Institut fuer Angewandte Radioaktivitaet, Leipzig). Z. Gesam. Hyg. Ihre Grenzgeb.; 16: 188-91 (Mar 1970). (In German).

The radium content of different types of flue-ash was determined. Ranging from 0.6 to 4.7 pCi/g flue-ash, it is within the ranges of variation stated in the literature. No remarkable differences between bituminous coal samples and brown coal samples were detected nor any differences depending on the geological formation. Contrary to this, the geographic differences were clearly obvious. From the quantity of flue-ash emitted no inadmissibly high emission values by coal-fed power stations in the GDR were found. Calculations were based on the most unfavorable long-term spreading factor in the atmosphere, as it generally occurs only at a source distance of about 1 to 2.5 km, as well as on the assumption that flue-ash behaves aerosol-like in its entire grain size distribution and may become particularly toxic by lung permeability. The radium concentration caused by coal-fed power-stations is, according to the Radiation Protection Ordinance at least 2 to 3 potencies below the admissible values for dwelling areas. For ThX the maximally admissible concentration with 7×10^{-12} Ci/m^3 is 23 times higher than for ^{226}Ra. Taking the random test performed as a basis, the ThX emission concentration maximally reaches only 1% of the maximally admissible concentration even for large-scale power-stations. (auth)

Radioactivity Transport and Monitoring

Refer also to abstracts 33540, 33845, and 35460.

33335 (INIS-mf-238) RADIOLOGICAL HEALTH AND SAFETY ASPECTS OF URANIUM MINING AND ORE TREATMENT. Safety Section Bibliography. Button, J. C. E. (comp.) (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Dec 1971. vp. INIS.

Two hundred and forty-four references are listed alphabetically under the headings: environmental problems; external radiation measurement; general radiological health and safety aspects; historical aspects; internal contamination hazards; measurements and protection; medical aspects; monitoring programs; radioactivity fundamentals; radiological exposure limits; standards and regulations; ventilation; and waste management. (INIS)

Atmosphere

Refer also to abstract 33315.

33336 (HASL-TM-71-21) ENVIRONMENTAL RADIATION IN THE CONTINENTAL UNITED STATES. Lowder, Wayne M.; McLaughlin, James E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Nov 1971. 20p. Dep. NTIS.

The observed radiation levels in populated areas are critically dependent on the radioactivity content of the upper layers of the soil, and radioactivity content of the building materials used for structures and roadway, the shielding effect of structures, the barometric pressure (which determines the cosmic radiation level), and the quantity of gamma-emitting radionuclides from fallout deposited on or in the ground. Given the possibilities for significant variations of any or all these factors over a small distance scale, it is evident that the quantitative characterization of the radiation environment of even a small town requires a considerable number of measurements. In particular, little value can be placed on a priori estimates of radiation levels for particular areas, based on "typical" figures for radioactivity concentrations in various media or for radiation levels measured elsewhere. The geographical pattern of radiation levels discussed above serves primarily to define the "expectation values" for future survey measurements. Despite the many environmental variables that effect the measured gamma radiation field at any point, existing measurements indicate a meaningful "typical" range of outdoor exposure rates, and there is little indication that most indoor levels are radically different. Estimates of typical contributions to the total radiation field in 1971 are tabulated. It seems likely that the vast bulk of the United State population is exposed to gamma radiation fields of 7 ± 4 μR/hr (60 ± 35 mR/year). To this must be added the cosmic-ray contribution, 3.5 μR/hr or more depending on altitude. Natural terrestrial gamma-ray levels in excess of 20 μR/hr are undoubtedly rare, and can be considered anomalous in the sense that one would certainly be immediately interested in seeking the cause of such a reading when it was observed. (auth)

33337 (UM-RSMAS-72031) STUDY OF TRITIATED HYDROGEN AND ITS COMPOUNDS IN THE ENVIRONMENT. Progress Report, August 15, 1971–April 15, 1972. Oestlund, H. Goete (Miami Univ., Fla. Rosenstiel School of Marine and Atmospheric Sciences). Contract AT(40-1)-3944. 14p. Dep. NTIS.

In addition to the existing ground-level stations for atmospheric HT and HTO in Miami and Fairbanks, a third station was established at the Mauna Loa Observatory, Island of Hawaii. Routine sampling and analysis of the samples from all three ground stations on a twice-weekly basis have been continued. Data up to the end of 1971 are available. A longitudinal profile from the U.S. to 65°S of HT and HTO was collected. A second Big Green Box, aircraft sampler, was built and six vertical profiles on the NCAR Sabreliner were sampled. A sampling system for the RB-57F aircraft is presently under construction. (auth)

33338 MODEL FOR IN-CLOUD SCAVENGING OF COSMOGENIC RADIONUCLIDES. Davis, W. E. (Battelle-Northwest, Richland, Wash.). J. Geophys. Res.; 77: No. 12, 2159-65(20 Apr 1972).

Results are presented from a model developed to evaluate deposition of cosmogenic radionuclides picked up by cloud water. The results are an in-cloud scavenging coefficient of $>10^{-4}$ sec^{-1} for ^{24}Na and $>10^{-3}$ sec^{-1} for ^{38}Cl and ^{39}Cl. (auth)

33339 SOURCES OF ^{210}Po WITHIN THE TROPOSPHERE. Marenco, A.; Fontan, J. (Univ., Toulouse). Tellus; 24: No. 1, 38-46(1972).

The importance of fossil, terrestrial, stratospheric and artificial sources of ^{210}Po is discussed. Results of 1 to 3 day measurements (1.5 meters above ground level) of ^{210}Po, ^{210}Pb, long-lived nuclides and of products representative of pollution are given. These measurements were taken in southwestern France and were used for estimations of the origin of ^{210}Po. It was concluded that tropospheric ^{210}Po is of natural origin and derived essentially from the decay of the ^{210}Pb present in the atmosphere. (Sweden)

Water

33340 (NVO-1229-113(Pt.1)) TRITIUM ANOMALIES ON AMCHITKA ISLAND, ALASKA. PART I. Castagnola, D. C. (Teledyne Isotopes, Palo Alto, Calif.). Jul 1969. Contract AT(29-2)-1229. 41p. Dep. NTIS.

The Long Shot event occurred at Amchitka Island, Alaska, on 29 October 1965. The event involved the detonation of an 80-kt nuclear device at a depth of 2,300 feet underground. Tritium resulting from the Long Shot explosion was detected in several sources of water in the vicinity of Long Shot surface ground zero several months to years after the detonation. The ^{3}H content in these sources reached levels several thousand tritium units above the ^{3}H content in water sampled far from the test site. However, the levels of ^{3}H contamination in surface water were well below the Concentration Guide of 1×10^{-3} microcuries per milliliter of water set by the U.S.A.E.C. as a standard for radiation protection for continuous exposure in an uncontrolled area. The movement of Long Shot-produced ^{3}H from the explosion zone to the surface probably resulted from dynamic-phase expansion of gaseous ^{3}H and/or displacement of gaseous ^{3}H during cavity collapse and/or displacement due to ground water infill. (auth)

33341 (NVO-1229-157) INTERIM SUMMARY OF TRITIUM DATA FOR STS "A", AMCHITKA ISLAND, ALASKA, JULY 1, 1969 THROUGH JUNE 30, 1970. Essington, E. H.; Forslow, E. J.; Castagnola, D. C. (Teledyne Isotopes, Palo Alto, Calif.). Dec 1970. Contract AT(29-2)-1229. 99p. Dep. NTIS.

Several sites on Amchitka Island, Alaska, were used by the U.S.A.E.C. for underground nuclear testing or are under consideration for such use. The results are presented of tritium determinations and other hydrologic information obtained from analyses made during the period July 1, 1969, to June 30, 1970, on environmental water samples collected in the vicinity of these sites. Since initial sampling in 1966, general sampling programs have been expanded to include the immediate vicinities of Long Shot and Milrow sites where underground nuclear tests occurred on October 29, 1965, and October 2, 1969, respectively. An extensive sampling and analytic program was begun shortly after the Milrow event to provide information for evaluating its radiological effects. Environmental samples of water from peat, ponds, streams, shallow wells, precipitation collectors, and the Pacific Ocean and Bering Sea were collected and analyzed for tritium by liquid scintillation and internal hydrogen-gas counting techniques. (auth)

33342 (PNC-N-831-70-2, pp 91-8) URANIUM CONTAMINATION OF THE SHINKAWA RIVER. Ouchi, Shin-ichi; Ogawa, Iwao; Masuda, Sumio; Kurabayashi, Mizumi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700227-3).

From fifth annual meeting of Japan Health Physics Society; Tokai, Japan (9 Feb 1970).

Low-level uranium liquid waste, about $1 \times 10^{-7} \sim 2 \times 10^{-7}$ μCi/cm^{3} in gross beta activity, was discharged from Tokai Works to the Shinkawa River downstream for about 10 years. The total amount of the uranium released is estimated to be about 64 mCi. Weight of this value calculated from chemical analysis is about 6×10^{2} kg. According to results of routine monitoring, no appreciable increase of uranium contamination of the river water and mud was observed. Environmental surveys of the Shinkawa River were carried out, placing emphasis on the river mud. It was found that the uranium liquid waste was diluted several times in volume in the Junichogawa, and 50 to 100 times between the junction and mouth of the Shinkawa, progressively. The radioactivity level of the Junichogawa was about 100 times as high as that of background. For biota samples, crawfishes (Cambaroides Clarkii) from benthos, cracians (Carassius Auratus) from nekton, and reed from plant, the uranium content was determined by fluorometric analysis. No appreciable contamination was found in the animal samples, while the uranium content in some plant samples was a little higher than that of other natural samples. (Japan)

Ecosystems and Food Cycles

Refer also to abstracts 33318, 33320, 33808, and 33816.

33343 (COO-3568-1) [PLUTONIUM CONCENTRATION ALONG FRESH-WATER FOOD CHAINS OF THE GREAT LAKES, U. S. A.] General Summary of Progress, 1971–72. (Woods Hole Oceanographic Institution, Mass.). Contract AT(11-1)-3568. 26p. Dep. NTIS.

Results of measurements of ^{238}Pu, ^{239}Pu, and ^{240}Pu in water, sediment, and biota from Lake Ontario are presented. Information is summarized on sampling methods, Lake Ontario samples, Lake Michigan samples, water analyses, and biota and sediment sampling and analysis. (J.R.D.)

33344 (INIS-mf-203) TRANSPORT OF SUBSTANCES IN VEGETABLE FOOD WITH REGARD TO RADIOACTIVE CONTAMINATION AND DECONTAMINATION. Paulus, K. O. (Karlsruhe Univ. (West Germany)). 24 Jul 1970. 105p. (In German). INIS.

Thesis.

The problems of the transport of substances in plant tissues has been treated experimentally in potato slices, as well as theoretically, with emphasis being laid on the effective mechanism. The radionuclides ^{137}Cs, ^{90}Sr, ^{85}Sr, ^{95}Zr and ^{144}Ce were chosen because of their frequent presence in the radioactive fallout. A description is given of the structure of plant tissue and the metabolism and the results of experiments concerning the uptake of radionuclides and its dependence on the concentration of solutions, form and size of tissue slices, the variety and age of potatoes. The processes having a share in the uptake and transport of radionuclides are considered, based on the results of the above mentioned experiments. It was shown that in the plant tissue the transport of substances is determined not only by pure diffusion but also by osmotically caused absorption of ions and their binding to the tissue by physiologic-chemical processes. The possibilities of decontamination of potatoes and other vegetables are demonstrated. Based on results from the above experiments, techniques are pointed out which seem to be promising. The suitability of these techniques has been proved by experiments. (INIS)

33345 SOVREMENNYE PROBLEMY RADIOBIOLOGII. TOM II. RADIOEKOLOGIYA. (Contemporary Problems of Radiobiology. Volume II. Radioecology). Kuzina, A. M. (ed.). Moscow; Atomizdat (1971). 422p.

This monograph is concerned with contemporary radioecology, or the science of the action of ionizing radiations on biological organisms, their environment, and the migration of radionuclides in the biosphere. The migration patterns of natural and artificial radionuclides among natural communities (terrestrial, marine, fresh water, etc.) are reviewed at length. The accumulation of radioisotopes in plants, animals, and man, and the consequent behavior in biological cycles and food chains are discussed. An evaluation of the effect of the increased radiation background on plant and animal populations is made. (1,179 references) (K.S.W.)

Radiometric Techniques

Refer also to abstract 33463.

33346 (CONF-710544) TRANSACTIONS OF THE SPWLA TWELFTH ANNUAL LOGGING SYMPOSIUM, MAY 2–5, 1971, DALLAS, TEXAS. (Society of Professional Well Log Analysts, Houston, Tex. (USA)). 436p.

Twenty-nine papers on well-logging equipment and methods and the interpretation of well-logging data are presented. A separate abstract was prepared for each of 10 papers. Nineteen papers were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 33347–33356.

33347 (CONF-710544–, Sect.G) NEUTRON ACTIVATION FOR ELEMENTAL DETERMINATION IN BOREHOLES. Wichmann, P. A. (Dresser Atlas, Houston, Tex.). 1971. 18p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

Some of the neutron activation logging methods which have been used over the past few years are reviewed. Due to the state of the art for activation logging instruments, these methods depend almost entirely on the half-lives and radiation intensity of the activation products. The elements which are most conveniently identified in this manner include oxygen, silicon, and aluminum. Field examples of the logs and/or measurements involved in each of these determinations are included. The application and relative value of each of these determinations, the discussion of limitations of the presently available field techniques, and possible solutions of the limiting problems are all discussed. The most likely solution of these problems is primarily related to the use of gamma spectral measurements to define the activation products. Field examples of test data that support the validity of these solutions are also presented. The method is shown to be a viable approach for determining lithologic components (through elemental assay) in well bores containing a wide range of conditions. While having certain limitations, the techniques described have the almost singular advantage of being direct measurements of the elemental constituents under investigation, while other methods described in the literature tend to be indirect or empirical approaches. (auth)

33348 (CONF-710544–, Sect.I) METHOD OF CALCULATING THE CAPTURE CROSS SECTION OF OIL FOR USE WITH PULSED NEUTRON CAPTURE LOGS. Richardson, J. E. (Shell Oil Co., Midland, Tex. (USA)). 1971. 7p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

The value of the neutron capture cross section of oil, Σ_0, will depend upon the types of hydrocarbons present and can vary with changes in reservoir pressure. The use of generalized correlation charts may lead to Σ_0 values which are significantly in error. For calculating Σ_0, use has been made of U. S. Bureau of Mines distillation data and of PVT data. An example calculation is given for the Helen Gohlke field, Texas, where the generalized chart value was 50 percent higher than the value calculated from this technique. It was concluded that the capture cross section of oil should be calculated, where possible, for each separate oil reservoir for use in quantitative interpretation work with pulsed neutron logging. (auth)

33349 (CONF-710544–, Sect.L) INTERPRETATION OF THERMAL NEUTRON DIE-AWAY LOGS SOME USEFUL RELATIONSHIPS. Threadgold, P. (British Petroleum Co. Ltd., Sunbury-on-Thames (England). Research Centre). 1971. 16p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

The use of thermal neutron capture cross section measurements as a porosity indicator is discussed. How the logs may be used to check the consistency of other log derived parameters is described and the possibility of using capture cross section as an additional factor in helping to identify lithology changes is mentioned. The major application of the measurement to assessing the magnitude of changes in relative fluid saturation with production is also considered. (auth)

33350 (CONF-710544–, Sect.M) NEW QUALITATIVE PERMEABILITY INDICATOR. Engelke, C. P.; Hilchie, D. W. (Dresser Atlas, Midland, Tex.). 1971. 10p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

A new method of detecting invasion (permeability) in low porosity and deep invasion formations is presented. The method is particularly applicable to West Texas type rocks, in which the permeability is primarily due to fracture or large vugs. The system requires the use of salt base or boron treated mud, and a computer plot of the porosity logs and the Neutron Lifetime Log. The system can be run in open or cased holes immediately after the drilling of the well. (auth)

33351 (CONF-710544–, Sect.N) EXCAVATION EFFECT. Segesman, F. (Schlumberger Ltd., Ridgefield, Conn.); Liu, O. (Schlumberger-Doll Research Center, Ridgefield, Conn.). 1971. 24p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

In neutron well logging, the neutron log responds only to the hydrogen of the formation. If two formations have the same amounts of hydrogen but one formation has some matrix materials replaced or "excavated" by low-density gas in the matrix, the neutron log readings which indicated the porosity of the formation are lowered. Numerical methods for estimating the excavation effect and for compensating for this effect when interpreting neutron logging porosity data are described. (L.C.L.)

33352 (CONF-710544–, Sect.P) APPLICATIONS OF THE SARABAND SAND-SHALE TECHNIQUE IN NORTH AMERICA. Ratliff, J. R.; Williams, F. G. (Schlumberger Well Services, Houston, Tex.); Throop, W. H.; Hall, J. D. (Schlumberger Offshore Services, Houston, Tex.). 1971. 23p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

The results of SARABAND sandy-shale computations performed in several wells of the North American Continent are presented. The method and program based on the formation model adopted to represent the sand and shale series are discussed and two new routines, the automatic detection of coal and lignite and an improved technique for measuring hydrocarbon density, are described. Four actual field examples of computations are presented showing some of the various stages of the processing work from original logs to final SARABAND output. In each case, an assessment of the accuracy of the results against geological or production data is given. (auth)

33353 (CONF-710544–, Sect.V) RECOGNITION OF POTENTIALLY PRODUCIBLE OIL AND GAS ZONES IN CASED HOLES WITH NEUTRON LIFETIME LOGS. Hoffman, G. W. (Davis Brothers Oil Producers, Tulsa, Okla.). 1971. 10p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

Pulsed neutron logging service, currently available under the trade name "Neutron Lifetime Log" by Dresser Atlas, offers a means of calculating water saturation ($S_{w\Sigma}$) in the completed cased hole; or in the open hole itself, under favorable conditions. Drawing an analogy from the "moveable-oil-plotting" technique; a means has been devised to present from the recorded Σ curve, a value of apparent water-filled "porosity" (ϕ_Σ), as seen by the pulsed neutron log. Overlaying this ϕ_Σ onto an independently derived log of true porosity (ϕ_t), recorded on compatible linear scale, yields an "eyeball estimate" or qualitative value of water saturation ($S_{wa\Sigma}$). The overlaid curves of ϕ_Σ and ϕ_t will "stack" in zones of 100% water saturation and "separate" in zones of interest. A separate and detailed calculation incorporating appropriate values for Σ_w, Σ_h and Σ_{ma} within the zones of "separation" displayed on the ϕ_Σ/ϕ_t overlay permit analysis of water saturation ($S_{w\Sigma}$). Complementing the Neutron Lifetime Log, a unique combination acoustic-epithermal neutron cement bond tool has been made available by Dresser Atlas. This combination tool can simultaneously record on a second surveying run, both acoustic and neutron porosities through bonded casing, with the supplementary benefit of identification of minerals and secondary porosity. Both the existence and quality of cement bond can be detected and evaluated, even in "hard rocks", employing the "Half Wave Acoustic Signature" presentation now available with the combination tool. (auth)

33354 (CONF-710544–, Sect.W) SOME PROBLEMS AND UNCERTAINITIES IN LOG INTERPRETATION. Threadgold, P. (British Petroleum Co. Ltd., Sunbury-on-Thames (England). Research Centre). 1971. 19p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

There is little doubt that in the majority of practical cases, values for porosity and water saturation values derived from modern log measurements using modern detailed interpretation methods have accuracy limits which are extremely acceptable. However, in critical cases where different measurements of nominally the same parameter do not agree (e.g., core and log derived porosities), it is often extremely difficult to define the real reason for the disagreement. The various possible sources of error can be qualitatively stated, but little work on quantitative assessment of these possible errors in log derived values has been done. In most cases examination of the possible errors in these values comprises four distinct aspects: a definition of what is actually measured by the various tools; the accuracy of the measurement made; the relationship between the tool measurement and the desired information; and the validity of the model of the borehole and reservoir used to carry out the evaluation. It is considered that a critical re-examination of many of these is required, and should now be possible using up to date equipment and techniques. One practical result of this would be to justify the knowledge gained from experience. More importantly it would provide a real basis for assessing the additional cost of running additional logs, in terms of improvement in accuracy of the resulting information. (auth)

33355 (CONF-710544–, Sect.X) SIDEWALL ACOUSTIC NEUTRON LOG. Guy, J. O.; Youmans, A. H. (Dresser Industries, Inc., Houston, Tex. Petroleum Services Div.); Smith, W. D. M. (Dresser Industries, Inc., Calgary, Alberta). 1971. 16p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

After extensive field testing in its experimental stage, a Sidewall Acoustic Neutron logging instrument was placed in limited field operation. The instrument in its present configuration yields a simultaneous recording of an acoustic interval transit time (Δt) curve, a neutron porosity curve, a caliper curve, and an optional gamma curve. The neutron curve is obtained from a conventional epithermal sidewall neutron pad mounted on a mechanical carrier equipped with a hydraulic retractor. Mounted on the same carrier but contacting the opposite side of the borehole is the sidewall acoustic section. The entire acoustic section, consisting of a transmitting transducer and two receiving transducers, is contained in a pad approximately two feet in length. The receiver spacing is 6.0", producing an acoustic interval transit time curve with much sharper interface resolution than that obtained from a conventional acoustic logging device. The quality of information obtained from the sidewall acoustic has been found to be as good as or better than that obtained from conventional acoustic logging instruments. The simultaneous acquisition of acoustic derived porosity and neutron derived porosity can be used for "quick look" detection of gas bearing strata. The resolution of the sidewall acoustic curve may be used for thin bed reservoir analysis. Due to the unique construction of the acoustic section, wave forms are obtained which have less borehole effect than those obtained with conventional acoustic sections and thus lend themselves to studies of the shear and compressional waves. Examples are given of logs made under various conditions, and results are discussed. Information which may be derived from waveform studies is also discussed. (auth)

33356 (CONF-710544–, Sect.Z) APPLICATIONS OF THE CORIBAND TECHNIQUE TO COMPLEX LITHOLOGIES. Schmidt, A. W. (Schlumberger Well Services, Midland, Tex.); Land, A. G. (Schlumberger Offshore Services, Houston, Tex.); Yunker, J. D. (Schlumberger of Canada, Calgary, Alberta); Kilgore, E. C. (Schlumberger Well Services, Houston, Tex.). 1971. 37p.

From SPWLA twelfth annual logging symposium; Dallas, Tex. (2 May 1971).

The CORIBAND computer program has been used to solve interpretation problems in reservoirs of complex lithology. The general CORIBAND technique is reviewed and field examples of practical interest in wells in the United States and Canada are discussed. Log-data crossplots used to determine CORIBAND options and select parameters are shown. These include the Z-PLOT which allows simultaneous interpretation of any combination of three logging parameters. The choices of "interpretation models" and shale parameters are discussed. In each example, the CORIBAND results are compared with the available geological data and production history. (auth)

33357 (RLO–2221-T-3-2) ROLE OF PAPER MILL ADDITIVES AS POTENTIAL STREAM POLLUTANTS: DEVELOPMENT OF NUCLEAR TECHNIQUES. Annual Progress Report No. 2, June 1, 1971–May 31, 1972. Chatters, Roy Milton (Washington State Univ., Pullman. Research Div.). 1 Mar 1972. Contract AT(45-1)-2221. 73p. Dep. NTIS.

A study was undertaken to develop nuclear analytical techniques where needed for better controlling paper mill additives to prevent their release into the environment as pollutants. Research on the detection and quantitative determination of starch and glucose was continued and expanded. Because starch is the largest in amount of the additives used in the paper industry, and glucose is a by-product of starch, and these two substances have a marked effect upon the biochemical oxygen demand (BOD) of effluent streams, they received a great deal of attention in this research. A new method for the determination of glucose, and in turn starch, was developed based upon the reduction of mercury compounds by glucose followed by the use of diatomaceous earth to recover all mercury so liberated from its compound. The new technique was satisfactorily employed under actual mill operating conditions. Extensive studies were made in the laboratory and cooperatively with paper mill personnel to determine the correlation between glucose levels and BOD on the same effluent samples. An adhesive-type additive was successfully tagged with a metal element and tested twice under normal mill operating conditions. This was done to solve a serious mill problem. It was also found that a metallic bleach compound could be readily detected by neutron activation analysis in paper and in effluents. The metal was present in non-toxic quantities in the finished product as well as the effluent. A method was developed for tagging one of the important non-starchy sizing compounds with a metal element. The resultant product was found by a paper-chemicals company to yield identical test results on paper as did the untagged compound. The tagged sizing has not yet been tested under mill conditions. One filler and whitening compound was tested and found to be satisfactory for neutron activation analysis as well as by means of x-ray fluorescence spectrometry. A radiation facility using ten americium beryllium neutron sources was fabricated, flux measurements made, and a number of radiochemicals produced. For neutron activation analysis, a new type of irradiation container was developed and has been adopted by other investigators. Wherever possible during the investigations to date, samples for study were collected in cooperating paper mills under normal conditions. All test materials used in the laboratory were obtained from mill stocks or from the suppliers of paper mill additives. (auth)

33358 (UCRL-Trans–10591) RESULTS OF MATHEMATICAL MODELING OF GAMMA–GAMMA LOGGING UNDER OIL-WELL CONDITIONS. Gulin, Yu. A.; Ponyatov, G. I. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Tr., Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 7, 3-20(1969). 26p. Dep. NTIS.

Results of the modeling are described as related to distribution of gamma radiation in homogeneous mediums, dependence of gamma scattering into the detector on sonde length, effects of drilling mud density on gamma scattering into the detector, spectra of scattered gamma, configuration of the GGL curves at bed boundaries, maximum ranges of GGL, and collimation of recorded radiation. (J.R.D.)

33359 (UCRL-Trans–10597) ANALYSIS OF AMPLITUDE, TIME AND SPACE CHARACTERISTICS OF THE GAMMA-QUANTA DISTRIBUTION IN PULSED NEUTRON–GAMMA LOGGING. Polyachenko, A. L.; Gavrina, T. E.; Tseitlin, V. G.; Shaposhnikova, T. A. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Tr. Vses. Nauch.-Issled. Inst. Yadern. Geofiz. Geokhim.; No. 7, 40-56(1969). 28p. Dep. NTIS.

The time and space distribution of radiation-capture γ quanta are considered in the approximate model of pulsed neutron–γ logging. The time and space parameters of this distribution are analyzed separately. An algorithm is proposed for quantitative determination of the mean lifetime of thermal neutrons within the formation by pulsed neutron–γ logging. Investigations were carried out on the amplitude, time, and space characteristics of the distribution of γ quanta over wide ranges of delay times, sonde lengths, borehole radii, and hydrogen contents of the formation. (M.C.G.)

33360 ISOTOPIC ABUNDANCE OF MOLYBDENUM IN TERRESTRIAL MINERALS. Stevens, C. M. (Argonne National Lab., Ill.). J. Mass Spectrom. Ion Phys.; 8: No. 4, 251-7 (Apr 1972).

The isotopic abundance of molybdenum has been determined in molybdenite and wulfenite minerals from six locations all over the world and no anomalies have been found greater than 0.15%. No results were obtained with respect to differences in mass-dependent fractionation of the samples because of overriding instrumental mass discrimination. (auth)

33361 EXTRACTION AND RADIOCHEMICAL METHODS IN THE DETERMINATION OF URANIUM ISOTOPES IN GROUND WATERS. Surganova, N. A.; Gorbushina, L. V.; Spiridonov, A. I.; Tyminskii, V. G. (Moscow Geological Prospecting Inst.). Izv. Vyssh. Ucheb. Zaved., Geol. Razved.; 14: No. 1, 100-5 (1971). (In Russian).

Determination of isotopic ratios of uranium in natural waters is generally accomplished in three steps: concentration of the U with an adsorbent, removal of the U from the adsorbent, and alpha spectrometric measurement. A number of published methods were tested for efficiency and accuracy, including U adsorption on activated carbon, or on iron hydroxide. Since accurate alpha spectrometry depends on a high degree of purification of the U sample, exchange chromatography and extractive methods based on the use of TBP, Complexon III, and ammonium oxalate are discussed as purification techniques. (K.S.W.)

33362 DETERMINATION OF THE AMOUNT AND SPATIAL DISTRIBUTION OF URANIUM IN FLUORITES FROM THE TRACKS OF URANIUM FISSION FRAGMENTS. Berzina, I. G.; Mel'nikov, I. V.; Popenko, D. P. At. Energ. (USSR); 32: No. 3, 211-15(Mar 1972). (In Russian).

Tin and uranium–molybdenum deposits were investigated in fluorites and host rocks of fluorite. The amount and spatial distribution of uranium in fluorites and their host rocks were determined by the method of f-radiography. The investigation of the spatial distribution of uranium was carried out directly on fluorite crystals by means of chemical etching as well as by means of special detectors which recorded the tracks of the induced uranium fission. Investigations were carried out on the identification of etched patterns on the tracks from fission fragments. It has been demonstrated that the difference between etched patterns on the tracks from fission fragments and etched patterns on dislocations makes it possible to distinguish between the uranium captured in a crystal lattice of fluorite during its formation and uranium penetrating a fluorite crystal along fissures during subsequent processes. It has been demonstrated also that the concentration of uniformly distributed uranium in a fluorite lattice does not exceed $n \times 10^{-5}\%$ by weight and that during the growth of crystals the "excess" uranium settles along the faces of growth or is concentrated in the marginal zones of crystals. It has been found that host rocks of fluorite contain two to three orders of magnitude more uranium than the fluorite crystals. The distribution of uranium in rocks is extremely non-uniform: there are observed large quantities of small grains of uranium minerals and uranium concentrations appearing at the detector as stars. It has been shown that the presence of excess uranium and an increase of uranium in the crystalline lattice of fluorite may serve as a prospecting guide for the discovery of ore bodies having an elevated uranium content. (5 figures, 2 tables, 11 references.) (auth)

Site Surveys

Refer also to abstract 33310.

33363 (WASH-1524) WAGON WHEEL GAS STIMULATION PROJECT, SUBLETTE COUNTY, WYOMING. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Apr 1972. 208p. Dep. NTIS.

Project Wagon Wheel is an experiment in which 5 underground nuclear explosives would be sequentially detonated in central western Wyoming to determine whether nuclear stimulation would be an acceptable and economic method for developing the thick, low permeability natural gas reservoirs in that region. The environmental impact of site construction and explosion detonation was studied. Data are presented on the seismic effects, radioactivity releases, commitments of resources, waste management requirements, costs, alternative energy resources, and alternative gas producing methods. After assessing anticipated benefits against environmental costs, the AEC concluded that the Wagon Wheel experiment may be considered a prudent investment of capital against minimal environmental costs. (L.C.L.)

Thermal Effluents

Refer also to abstracts 35458, 35515, 35516, 35530, 35538, 35543, 35544, and 35547.

33364 (COO-2160-4) INVESTIGATION OF THE INFLUENCE OF THERMAL DISCHARGE FROM A LARGE ELECTRIC POWER STATION ON THE BIOLOGY AND NEAR-SHORE CIRCULATION OF LAKE MICHIGAN. PART A: BIOLOGY. Technical Progress Report, August 1, 1971–April 30, 1972. [Wisconsin Univ., Milwaukee. Center for Great Lakes Studies]. Contract AT(11-1)-2160. 16p. Dep. NTIS.

Monthly studies of the Oak Creek plant area and a similar control area were begun in September 1971 and continued for 6 months. Temperature profiles were determined, water samples taken for phytoplankton and chemical analyses, and plankton determinations were made. At no time was the thermal plume detected at any of the sampling stations. Information obtained does not indicate any influences that can be directly traced to the thermal discharge. (M.C.G.)

33365 NUCLEAR POWER ON CAYUGA LAKE. Eipper, Alfred W. (Cornell Univ., Ithaca, N. Y.). Environ. Aff.; 1: No. 1, 165-90(Apr 1971).

The history of the controversy over threats to Cayuga Lake, N. Y. from a proposed electric power plant is reviewed. Information is included on the nature of steam electric stations, Cayuga Lake, plans of the utility company, position taken by scientists, public response, utility company response, and legislators response. It is noted that the power plant is dormant and probably will remain so until about 1978. (J.R.D.)

33366 PROBLEM OF WARM WATER RELEASED FROM NUCLEAR POWER STATIONS. ITS EFFECTS AND THE COUNTERMEASURES. Shimanuki, Ryoichi (Japan Atomic Energy Research Inst., Tokai). Atomu; 16: No. 7, 8-25(Aug 1971). (In Japanese).

Japan is surrounded with sea, and therefore cooling water for power stations is taken from the sea. Not much problem if capacity of the power plants is not large. With rapid increase in nuclear power plants, however, effects on coastal fisheries are taking increasing significance, as one aspect of public hazards. In this connection, the following are described: warm water released from the nuclear power stations; the situation in overseas nuclear power stations; formation of warm-water regions and their behavior; effects of the warm water on fishes; cooling ponds and towers for the released warm water; and utilization of the warm water in the coastal fisheries. (Japan)

33367 LOW-EXCESS AIR-FIRING TECHNIQUE TO CUT EFFLUENT FROM LENNOX STACKS. Elec. News Eng.; 80: No. 9, 28-31(Sep 1971).

Control measures undertaken by Ontario Hydro include installation of 99.5% efficient electrostatic precipitators at its generating stations, tall stacks to promote effluent dispersion, conversion to natural gas at one plant, and construction of an oil-fired generation station. The latter will have two 650-ft stacks and will employ a low-excess air-firing technique successfully used in Europe and Japan. This involves an accurate balancing of fuel, oil, and air, a process that is not possible with coal. Hydro is also studying methods of utilizing waste heat from its giant nuclear plant and an apparatus for removing sulfur dioxide from stack gases by reaction with limestone. (Air Pollut. Contr. Ass. Abstr.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 33554 and 34114.

33368 COLLECTIVE-EFFECT ACCELERATORS. Keefe, Denis. Sci. Amer.; 226: No. 4, 23-33(Apr 1972).

The collective effect is discussed; and examples of the use of the collective effect are given, including the Astron plasma-containment device and the HIPAC (heavy-ion plasma accelerator). The historical development and present status of collective-effect accelerators are reviewed, and the electron-ring accelerator at the Lawrence Berkeley Laboratory is described. (W.H.K.)

General Detectors and Monitors

Refer also to abstracts 33091, 33097, 33098, 34024, 34120, 34121, 34123, 34985, 35401, and 35460.

33369 (AEEW-R-762) LARGE VOLUME PROPORTIONAL COUNTER FOR NEUTRON FLUX MEASUREMENTS AT ENERGY LEVELS OF 4 MeV. Allen, F. H. (Atomic Energy Establishment, Winfrith (England)). Jan 1972. 15p. Dep. NTIS (U. S. Sales Only).

The construction and processing of a high resolution proportional counter, having a sensitive volume 1 meter long and 140 mm diameter, are described. Geometrical accuracy and gas purity are the governing factors in determining proportional counter resolution. Special techniques have been adopted to achieve a sufficiently high standard in these factors to give satisfactory performance in such a large counter. The processing and gas filling methods, based on ultra high vacuum techniques, are described in detail. (auth) (UK)

33370 (ANL-7908) MEASUREMENT OF FAST-NEUTRON FLUX WITH A LITHIUM-DRIFTED GERMANIUM DETECTOR. Smith, D. L. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 26p. Dep. NTIS.

The use of lithium-drifted germanium detectors for measurement of fast-neutron flux has been investigated. The detection mechanism proposed is observation of a prominent spectral line attributed to deexcitation of ^{72}Ge nuclei (excited by neutron inelastic scattering within the active region of the detector) from the 0^+ first-excited state to the 0^+ ground state via emission of an internal-conversion electron. A 4.0-cm^3 planar Ge(Li) detector has been calibrated for neutron-flux measurements over the energy range E_N = 700 to 5000 keV. The measured efficiency fluctuates considerably with energy for $E_N < 1400$ keV, but is relatively free of structure for higher energies. The absolute efficiency (ratio of neutrons detected to neutrons incident on the detector) has been determined to be $(8.2 \pm 0.5) \times 10^{-4}$ at E_N = 1500 keV, which is about 10% of the full-energy peak efficiency for 1332-keV ^{60}Co gamma rays. Insensitivity to thermal neutrons, gamma-ray discrimination capabilities, and stability are desirable features of this type of detector. Submicrosecond timing is not possible because the 0^+ first-excited state of ^{72}Ge has a 422-nsec half-life. Ge(Li) detectors suffer radiation damage from fast-neutron bombardment. However, the detector used in the present study continued to function effectively after receiving an integrated dose exceeding 10^{10} neutrons/cm^2. (auth)

33371 (CNEA-306) AUTOMATIC CONTROL OF THE DRIFTING PROCESS FOR SEMICONDUCTOR RADIATION DETECTORS. Erramuspe, H. J.; Sinderman, J. E. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1971. 14p. (In Spanish). Dep. NTIS (U. S. Sales Only).

An automatic Li drifting apparatus is presented which controls the temperature of the detector bath to maintain the leakage current at a preselected value. When the Li ions reach the back of the wafer the temperature is automatically reduced to room temperature, leaving or not, optionally, the bias voltage applied. The need for constant supervision is therefore eliminated. (auth)

33372 (COO-1198-893) ESCAPE PEAKS IN Si(Li) DETECTORS. Woodhouse, John B. (Illinois Univ., Urbana. Materials Research Lab.). [nd]. Contract AT(11-1)-1198. 2p. Dep. NTIS.

An equation for the escape peaks in Si(Li) detectors is given which is seen to be in fair agreement with experimental data. (W.H.K.)

33373 (DP-747) IONIZATION CHAMBERS FOR MEASURING TRITIUM IN PROCESS STREAMS. Anthony, John D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1962. Contract AT(07-2)-1. 29p. Dep. NTIS. Declassified 26 Oct 1971.

Ionization chambers of three different designs were developed for continuous measurement of tritium in the presence of hydrogen in process pipes and tanks. The chambers cover the range of 0.01% to 100% tritium concentration. (auth)

33374 (EUR-4762) INTERCOMPARISON RUN OF WHOLE-BODY COUNTERS IN THE COUNTRIES OF THE EUROPEAN COMMUNITIES. Schmier, H. (European Communities, Brussels (Belgium). Commission. Bundesgesundheitsamt, Berlin (West Germany)). Jan 1972. 50p. (In German). Dep. NTIS (U. S. Sales Only). EUR FB 70,-.

The Commission of the European Communities has, in collaboration with the Federal Health Office in Berlin, conducted an intercomparison run of whole-body counters with "living phantoms" and "water phantoms." The intention of this phantom comparison was not only to eliminate calibration differences in the personal comparison, but also to provide the measuring centers with the opportunity of introducing uniform weight and magnitude corrections for all devices. In spite of differences in measuring methods, geometry and measuring time, very good agreement was frequently achieved in the measurements. The calibration comparison with water phantoms confirmed to a considerable extent the results of the calibration comparison with persons. The agreement of the measurement results in the middle weight range can be regarded as good without any correction. The calibration comparison with living and water phantoms gave no reason to think that whole-body counters of a particular type offer any special advantages or disadvantages in this kind of measurement. With careful calibration, the potassium and cesium-137 content of persons can be determined with adequate accuracy even using less complex devices. (auth)

33375 (JUL-814-RX) METHOD FOR CALCULATION OF THE NEUTRON SPECTRUM IN THE INTERMEDIATE ENERGY RANGE BY MEANS OF ACTIVATION PROBES. Borchardt, G. (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Reaktorexperimente). Dec 1971. 48p. (In German). Dep. NTIS (U. S. Sales Only).

Outlined is a method for determination of the neutron spectrum in the intermediate energy range from about 0.5 eV to 100 keV with resonance activation probes. The premise is made that the neutron spectrum possesses a $1/E^{\alpha}$-shape and that the activation probes possess resonances at various energies in the activation cross section. It also assumed that the activation probe is of such thinness as to reduce the neutron self-absorption factor to 1. Tables and figures present activation cross sections for ^{197}Au, ^{59}Co, ^{66}Cu, ^{23}Na, and ^{45}Sc as well as data for determination of the cadmium cut-off energy. Also presented is the dependency on α for both activation resonance integrals and spectral indices. A program for the computation of α is presented. (H.B.G.)

33376 (KFK-EXT-4/71-30) INVESTIGATIONS OF THE NEUTRON ENERGY SPECTRUM IN THE LOWER eV REGION BY A "SCATTER PEEL-OFF METHOD." Bayer, A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1971. 83p. (In German). INIS.

A newly developed "scatter peel-off method" is described for investigations of the neutron energy spectrum in the lower eV-region and measurements are reported. This out-of-pile method utilizes the energy loss-scattering angle relation which governs the elastic neutron-hydrogen scattering. The differentiation of the angle-dependent reaction rate measured behind the scatterer by a cadmium covered ^{3}He-detector yields the structure of the neutron spectrum from the cut-off energy of cadmium near 0.6 eV up to an energy of about 50 eV, which is the limit set by the resolution of the device. The theoretical fundamentals are explained, the device is described and related problems are discussed. First measurements performed on a 1/E-spectrum, which was modified by known absorbers, showed the usefulness of this method. Further measurements performed on a hart spectrum were compared with measurements of resonance foils. (auth)

33377 (KHFTI-71-11) STUDY OF THE DISPERSION PATTERNS OF THE ACCELERATING STRUCTURE OF A LINEAR ACCELERATOR WITH STABILIZING MECHANISMS. Bomko, V. A.; Klyucharev, A. P.; Rudyak, B. I. (Akademiya Nauk

Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The accelerating assembly with a stabilizing device for a linear proton accelerator is discussed. The radial pin method of attaining a high degree of stability and an observed resonance discontinuity in the natural wave frequency and the resulting effect of changing the pin length and number were experimentally investigated. (K.S.W.)

33378 (LIB/Trans–421) MINIATURE FISSION CHAMBERS FOR FISSION RATE MEASUREMENTS IN RESEARCH REACTORS. Guery, M.; Jarrige, A. Translated by A. P. Marks for Australian Atomic Energy Commission, from Rev. Phys. Appl.; 6: No. 2, 121-7(1971). 13p. Dep. NTIS (U. S. Sales Only).

Miniature fission chambers are described for use as standards or references, for flux mapping, for measuring spectral indices, for absolute flux measurements, for cross section measurements, and for power measurements. The fissile coatings, filling gases, associated electronics, and pulse spectra are discussed. Also, some model miniature fission chambers are described. (W.H.K.)

33379 (ORO–2401-48) AN EXPERIMENTAL COMPARISON OF SCINTILLATION AND SEMICONDUCTOR DETECTORS FOR ISOTOPE IMAGING AND COUNTING. Brill, A. B.; Patton, J. A.; Baglan, R. J. [Vanderbilt Univ., Nashville, Tenn.]. [1971]. Contract AT(40-1)-2401. 31p. (CONF-720306–7). Dep. NTIS.

From Scintillation and semiconductor counter symposium; Washington, D. C. (1 Mar 1972).

Progress in the development of Si(Li) and Ge(Li) detectors for use in clinical diagnostic studies is outlined. The potential medical applications discussed include activation analysis, radioassay, radioisotope scanning, x-ray fluorescent scanning, x-ray fluorescence analysis, and flow studies. (W.H.K.)

33380 (ORO–2401-49) EVALUATION OF LITHIUM-DRIFTED GERMANIUM DETECTORS FOR ORGAN SCANNING. Patton, J.; Brill, A. B.; Rolfes, R.; Johnston, R. E. [Vanderbilt Univ., Nashville, Tenn.). [nd]. Contract AT(40-1)-2401. 19p. (CONF-710605–1). Dep. NTIS.

From eighteenth annual meeting of Society of Nuclear Medicine; Los Angeles, Calif. (28 Jun 1971).

Results of a study on the performance of Ge(Li) detectors for radioisotope scanning are given and discussed. The spatial resolution and sensitivity of Ge(Li) detectors and NaI scintillation detectors are compared. (W.H.K.)

33381 (ORO–2401-56) NEW APPROACHES TO THE IMAGING OF DISTRIBUTIONS OF STABLE AND RADIOACTIVE TRACERS WITHIN THE BODY. CHAPTER III. FLUORESCENT SCANNING. Patton, James Allen (Vanderbilt Univ., Nashville, Tenn.). [nd]. 43p. Dep. NTIS.

The development of fluorescent scanning technology for in vivo studies is reviewed. Research on fluorescent scanning of the thyroid gland using a Si(Li) detector, fluorescent scanning for measuring cerebral blood flow and blood volume using a Si(Li) detector, and fluorescent scanning of bismuth for tumor localization in the brain using a Ge(Li) or NaI(Tl) detector is summarized. (W.H.K.)

33382 (RD/B/N–2150) COFOCO 2: A PROGRAM FOR THE ANALYSIS OF FOIL ACTIVATION EXPERIMENTS. Waterson, R. H. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1971. 42p. Dep. NTIS (U. S. Sales Only).

COFOCO2 was written to supersede the earlier data handling program COFOCO, used extensively for foil activation experiment analysis. Count rates from foils, sources and background are fed into the program, which corrects them for known effects, such as half-life and deadtime. A statistical analysis of the results yields mean foil count rates and standard errors, rejecting any "outliers" on a χ^2 basis. Experimental results are listed in a format chosen by the user, and may also be obtained graphically and on punched cards. A permanent library of foil and source calibration factors is available on disc, but these may be temporarily modified during a run. The program was written with extensions to other types of analysis in mind, and the input is in free format suitable for reading large amounts of data from automatic collection devices. (auth) (UK)

33383 (UCRL–73295(Rev.1)) TRITIUM STACK MONITOR WITH A WIDE DIGITAL RANGE. Silver, W. J.; Shapiro, E. G.; Greenhouse, N. A.; Scown, K. M. (California Univ., Livermore. Lawrence Livermore Lab.). 3 Apr 1972. 15p. (CONF-710809–16). Dep. NTIS.

From Tritium symposium; Las Vegas, Nev. (30 Aug 1971).

The modified flowthrough ionization chamber system for monitoring the stack effluent from LLL Livermore's main tritium-handling facility is described. Output pulses from current-to-frequency converters are counted by seven-decade scalers. One scaler is used for long-term recording of activity released from the stack, and a second scaler is reset automatically every 15 minutes by an external timer. If total count during any 15 minute period exceeds certain preset limits, a high- or low-level alarm is sounded. The reset period and alarm points may be adjusted manually. (W.H.K.)

33384 SEMICONDUCTOR DETECTORS FOR NUCLEAR RADIATION MEASUREMENT. Deme, Sandor. New York; John Wiley and Sons, Inc. (1971). 319p. $13.95.

Translation of Felvezeto Detektorok Magsugarzas Meresere by J. M. Kovacs.

Topics include the interaction of nuclear radiation with matter, general properties of semiconductors, principle of operation and general features of semiconductor detectors, preparation of semiconductor detectors, application, and electronic equipment for semiconductor detectors. (190 references) (W.H.K.)

33385 SAMPLE CHANGING ELEVATOR AND LIGHT SEALING MECHANISM FOR SCINTILLATION COUNTING. Cannon, Raymond E. (to Beckman Instruments, Inc.). U. S. Patent 3,626,190. 7 Dec 1971. Filed 11 Apr 1966.

A sample-handling system for a liquid scintillation counter or the like is described. The system has a sinusoidal drive for a sample-changer elevator with a positively interlocked upper shutter mechanism and a lower light seal carried by the elevator, which overlaps the lower end of the elevator passage while the shutter is open. The mechanism is driven by a unidirectional motor. (2 figures) (auth)

33386 COMPTON PROFILE MEASUREMENTS BY USE OF SOLID-STATE DETECTOR. Fukamachi, T. (Tokyo Univ.); Hosoya, S.; Hosokawa, Y.; Hirata, H. Phys. Status Solidi (a); 10: No. 2, 437-46(16 Apr 1972).

It is practically impossible to measure the Compton profile of any heavy material, because its strong absorption very much reduces the intensity. This difficulty has been overcome by use of a nondispersive solid state detector (SSD) together with γ rays or high-energy x rays, because the effective intensity in this case becomes 10^2 to 10^4 times stronger than with the conventional dispersive crystal analyzer. As for the energy resolution, the ratio of the profile width to the resolution of an SSD can be made comparable with the conventional case by choosing a suitable radioactive γ-ray source. The preliminary measurements have already shown very promising results and suggest various applications feasible only by this innovation. (auth)

33387 METHOD OF COINCIDENCE AND ANTI-COINCIDENCE CIRCUIT CHARACTERISTICS MEASUREMENTS. Fyodorov, N.; Kryshkin, V.; Stibunov, V.; Usov, Yu. (Inst. of Nuclear Physics, Tomsk, USSR). Nucl. Instrum. Methods; 100 No. 1, 73-5(1972).

A method is described to measure automatically coincidence and anti-coincidence circuit characteristics by means of a time-to-amplitude converter that allows to obtain resolution curves of circuits apart from time spread in the detectors, to choose easily the time resolution required in a particular experiment, and to estimate accidental coincidences and efficiency of a circuit obviating the need for any variable delay lines and monitors. (auth)

33388 56-CHANNEL GONIOMETER FOR GAMMA–GAMMA DIRECTIONAL CORRELATION STUDIES. Gerholm, T. R.; Cho, Z. H.; Eriksson, L.; Gidefeldt, L.; Pettersson, B.-G. (Univ. of Stockholm). Nucl. Instrum. Methods; 100: No. 1, 33-43(1972).

A multi-channel goniometer (MCG) with eight detectors is described. All fifty-six coincidence combinations of two cascading gamma rays are analyzed in one common time-to-amplitude converter. Before the time analysis in the TAC is allowed, a logic system selects pulse pairs appearing within a preset time interval. This facilitates a reliable coding of the address register. The data are stored in the memory of a two parameter multi-channel analyzer. The MCG has been tested in a series of control experiments and computer checks with simulated data. The results show that the upper limit of the counting rate that may be allowed is set by single channel performance in the same way as for a two detector instrument. The high efficiency of the MCG can thus be fully utilized in absolute measurements of angular correlation parameters. (auth)

33389 COMPENSATED LEADING EDGE TIMING WITH FAST PHOTOMULTIPLIERS. Karlsson, L. (Royal Veterinary and Agricultural Univ., Copenhagen). Nucl. Instrum. Methods; 100: No. 1, 193-9(1972).

Investigations on the use of compensated leading edge timing in conjunction with fast photomultipliers are presented. The results indicate that this timing method is well suited for the study of nuclear level lifetimes. In order to adjust the timing circuits for optimum performance a light emitting diode, LED, scintillator-simulator was used. With a narrow dynamic range a time resolution of 175 ps fwhm was obtained with a ^{60}Co source using NE 111 plastic scintillators with 25 mm diameter and 10 mm height coupled to type XP 1021 photomultipliers. (auth)

33390 ANALYSIS OF POTENTIAL DISTRIBUTION IN A GASEOUS COUNTER OF RECTANGULAR CROSS SECTION. Tomitani, T. (National Inst. of Radiological Sciences, Chiba, Japan). Nucl. Instrum. Methods; 100: No. 1, 179-91(1972).

The potential in a gaseous proportional counter of rectangular cross-section can be expressed in an analytical form by means of conformal transformation of the Jacobian elliptic function. Equipotential lines and lines of force are calculated numerically for three cases. The potential in a gaseous counter with a multi-anode array can be expressed in a similar way. Formerly, hyperbolic sine functions have been used in the analysis of such a counter. The prominence of the present solution over the hyperbolic sine function is examined in the case where the anode-to-cathode distance is comparable or less than the intervals of the anodes. The potential distribution in the rectangular counter and in the multi-anode counter is compared with that of a cylindrical counter. Also, the potential distribution in the multi-anode counter with wire-cathodes midway between the anodes, in which a polarization effect on the anode and the wire-cathode is taken into account, is derived. (27 references) (auth)

33391 SIMPLE NON-LINEAR PULSE HEIGHT COMPENSATOR FOR USE WITH A TIME TO AMPLITUDE CONVERTER. Barton, R. D.; King, M. E. (Carleton Univ., Ottawa). Nucl. Instrum. Methods; 10: No. 1, 165-71(1972).

A simple non-linear pulse height compensator for use with a time to amplitude converter is reported. It consists of two resistances, a diode and a linear amplifier. Using a ^{60}Co source, a smooth residual walk curve with maximum time shift $\leq$30 ps over the upper 75% of the energy range was obtained. About 50% of the energy range is well fit by a straight line with total droop of (3 ± 3) ps from end to end. The circuit makes practical the walk corrections required in the delayed coincidence measurement of short lifetimes. (auth)

33392 POSSIBLE IMPROVEMENT IN MAGNETIC SPECTROGRAPHY BASED ON IONOGRAPHY. Demers, P. (Univ. of Montreal). Nucl. Instrum. Methods; 100: No. 1, 121-3(1972). (In French).

A post-irradiation histological technique allowing one to observe edgewise the normally irradiated silver bromide-gelatin detectors is described. This suggests a novel design of magnetic spectrographs: focal surface normal to the rays; a reduced size, thanks to the use of higher fields (super-conducting magnets); and analysis of the information, accumulated upon a reduced area, through an automatic track counting system. (auth)

33393 DIFFERENTIATION BETWEEN X RAYS AND GAMMA RAYS IN RADIOACTIVE MATERIAL. Umbarger, C. J.; Malanify, J. J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 100: No. 1, 201-2(1972).

A technique is described for differentiating between X-rays and gamma rays being emitted from the same radioactive sample. (auth)

33394 INVESTIGATION OF THE INTERFERRING EFFECT OF PHOSPHORESCENCE IN THE LIQUID SCINTILLATION COUNTING OF SOFT BETA EMITTERS. Fodor-Csanyi, P.; Levay, B. (Lorand Eoetvoes Univ., Budapest). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Chim.; 12: 51-67 (1971).

The interfering effect of phosphorescence and its possible elimination in single-channel instruments was studied extensively. It was established that the value of phosphorescence is not an additive quantity composed of the phosphorescence of the individual components (sample container, solvent, additives, etc.), because in the presence of the scintillator, phosphorescence occurring in the absorption bands of the solvent and the scintillator is also emitted in the emission range of the scintillator, thus increasing the phosphorescence measured. (auth)

33395 MEASUREMENT OF NUCLEAR RADIATION BURSTS WITH DETECTOR HAVING FINITE RESPONSE TIME. Sawamura, Sadashi; Ozawa, Yasutomo (Hokkaido Univ., Japan). Nippon Genshiryoku Gakkaishi; 14: No. 4, 152-8(Apr 1972). (In Japanese).

Pile-up phenomena arising in radiation burst measurements are studied. These phenomena are treated as a non-stationary stochastic process, and the following results have been derived: (1) If the single radiation response of the detector is exponential with time constant τ, the height of the resultant pulse due to the pile-up process satisfies the Kolmogorov–Feller equation. If the response exhibits finite rise time, the piled-up pulse height expressed by the sum of many single radiation responses satisfies the non-stationary shot noise process. (2) The expected value of piled-up pulse, when treated as a noise in energy spectral measurement, is proportional to the total energy of a burst. The expected value of piled-up pulse is also directly related to the single radiation response of the detector, so that the pile-up phenomena can be used to measure the radiation field quantities and to determine the single radiation response. (3) The distribution of piled-up pulse height approaches the special Gaussian distribution as λ (a mean value of arriving particles in unit time) increases, and the deviation of the piled-up pulse heights from their expected values becomes negligible, independently of the energy spectrum of incident radiation particles. (auth)

33396 NEW INSTRUMENTS CONTROL NUCLEAR PLANTS. Can. Chem. Process.; 56: No. 2, 32-5(Feb 1972).

New instruments and detectors developed as a result of Canada's nuclear power program are featured. Atomic Energy of Canada Ltd. (AECL) has developed the "self powered radiation detector," for measuring radiation levels in reactor cores. This instrument typically has a platinum core and Inconel sheathing separated by magnesia insulation; in a radiation field a current (of the order of microamps) flows between core and sheathing, and is measured. Improved resistance thermometers for reactor cores are manufactured by Rosemount Engineering, of Minnesota. Barringer Research Ltd. has developed an infrared meter for determining HDO in water or air. Champlain Power Reactors manufacture an adhesive indicator tape for detecting water leaks. Simtec Instruments Ltd. makes scintillation counters for tritium and nitrogen-16. AECL is replacing film badges for its workers by thermoluminescent dosimeters. (Canada)

33397 INDICATING OR DETECTING APPARATUS FOR NUCLEAR RADIATION SUCH AS GAMMA RAYS. Loveday, George Christopher. (to Ekco Instruments Ltd.). British Patent 1,270,587. 12 Apr 1972. Filed 3 Dec 1969.

An improved crystal scintillation detector is described comprising a mosaic of scintillation elements, optically screened from each other, and arranged in series of first and second element rows respectively parallel to first and second intersecting axes, each element being in a first and in a second row. A number of scintillation detectors are arranged to view the scintillation elements, the field of view of each detector extending over a number of elements and overlapping the field of view of neighboring detectors. Associated electronics and circuitry are described. These include means for summation of detector pulses, analysers, gating means comprising a number of logic gates, core or magnetic tape storage means and cathode ray tubes to provide analog displays. The system is arranged to utilize only scintillations of brightness within a predetermined range. (UK)

33398 IMAGE DETECTOR FOR DISPERSED FLUXES OF ENERGETIC PARTICLES OF γ QUANTA EMPLOYING A FIBER-OPTICS DELAY TECHNIQUE FOR ADDRESSED MULTI-CHANNEL COUNTING. Prydz, S. (Univ. of Oslo). App. Opt.; 9: No. 9, 2193-5(Sep 1970).

See NP–19247.

A design proposal for a charged particle or gamma imaging system is given. A scintillator is admixed to the surface of the specimen and is viewed by a faceplate with a coded fiber optics system. Two fiber optics structures are mounted on the faceplate and lead to two photomultipliers. One set of fiber optics is cut relatively short and the fibers are of equal length, whereas the fibers of the second set are cut with systematically increasing lengths. The delay time of the longer optics fiber is then used to locate the position of the incident radiation. (W.H.K.)

33399 SEMICONDUCTOR DEVICES FOR GAMMA RAY, X-RAY, AND NUCLEAR RADIATION DETECTION. Muggleton, A. H. F. (Nuclear Enterprises Ltd., Sighthill, Scotland). J. Phys., E (London); 5: No. 5, 390-404(May 1972).

The application of semiconductor devices to the detection and analysis of gamma ray, x ray, and nuclear radiations is outlined. After a brief discussion on semiconductor detector principles, including mode of operation, choice of material, and energy resolution, various types of semiconductor detectors are described. The uses of semiconductor devices in the fields of nuclear particle counting and spectrometry, gamma spectrometry, space physics, medical physics and energy dispersive x ray spectrometry are discussed. Despite the great importance of processing the detected signal, only brief mention is made of the electronic techniques used, emphasis being on the detecting devices themselves. (auth) (UK)

33400 NEUTROGRAPHY PRODUCT. Bredoux, F. J. M.; Mercier, C.; Phlipot, G. A. (to Kodak-Pathe). French Patent 2,067,103. 20 Aug 1971. Filed 4 Nov 1969. (In French).

A visible image of an object which modulates a neutron flux may be obtained using the product described and the proper treatment with an appropriate chemical reagent. A neutronographic process utilizing this product is also presented. The conversion layer contains an active compound with at least one of its active constituents capable of undergoing (n, α) type nuclear reactions (^{10}B compounds e.g. borates and ^{6}Li salts e.g. Li halides or Li borates). The recording layer contains a substance enabling α particles to be detected (cellulose nitrate). The active compound of the conversion layer is dispersed in a water-soluble bonding material which can be stripped off with water. This layer is in intimate contact with the recording layer. (France)

33401 FULL-LOAD SCINTILLATOR CHARACTERISTICS DURING RECORDING OF PULSED-SOURCE RADIATION. Pokrovskii, A. V.; Flesher, G. I. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 133-5(1971). (In Russian).

Scintillation counters find application in measuring fluxes of high-intensity gamma radiation generated in the form of short pulses. Crystal saturation may result from a large number of gamma quanta, wherein all scintillating centers are being excited. Theoretical treatment of the problem showed that a nonlinear dependence was observed between the absorbed energy and the crystal light output. An increase in the crystal dimensions does not lead to an increase in the linear portion of this dependence. (K.S.W.)

33402 TOTAL EFFICIENCY OF GAMMA-RAY DETECTION BY GERMANIUM SEMICONDUCTOR DETECTORS. Graudynya, L. Ya.; Kalnyn, Yu. R. H.; Pelekis, L. L. (Inst. of Physics, Riga). J. Radioanal. Chem.; 9: No. 2, 341-86(Dec 1971).

The total efficiency of γ-ray detection by Ge(Li) semiconductors is calculated for the energy range 0.1 to 10 MeV for cylindrical detectors with radii from 0.25 cm to 2.5 cm and thicknesses from 0.1 cm to 1 cm at distances between the source and detector ranging from 2 cm to 20 cm. (auth)

33403 DETERMINATION OF FLUORESCENT EFFICIENCY OF LIQUID SCINTILLATION BY β RAY OF ^{14}C. Onishi, Masayoshi; Niki, Eiji (Tokyo Univ.). Jap. Anal.; 21: No. 4, 511-17(Apr 1972). (In Japanese).

The fluorescent efficiency of a liquid scintillator (1l toluene + 4g PPO + 0.1 g POPOP) for carbon-14 beta particles was measured. The corrected fluorescent spectra and absorption spectra of the liquid scintillator and the absolute quantum efficiency curve of the photomultiplier were obtained. The fluorescent efficiency of the scintillator was found to be 2.6 ± 0.3%. (W.H.K.)

33404 CALIBRATION OF THE NEUTRON DETECTION EFFICIENCY OF A PLASTIC SCINTILLATOR, 1 TO 200 MeV. Edelstein, R. M. (Carnegie-Mellon Univ., Pittsburgh); Russ, J. S.; Thatcher, R. C.; (and others). Nucl. Instrum. Methods; 100: No. 2, 355-9(1972).

The absolute efficiency of a plastic scintillator neutron counter has been measured as a function of bias at thirteen neutron energies between 1.0 and 200 MeV, using two techniques: above 4 MeV, protons from free np charge exchange were used to tag a neutron beam, while below 4 MeV the tagged neutrons came from a ^{252}Cf fission source. Data are available for biases between 0.20 and 4.0 MeV electron equivalent. A Monte Carlo program was written to interpolate the measurements to different neutron energies and extend them to other counter geometries. A comparison of the results of the program with our measurements and those of others is presented. (auth)

33405 BACKGROUND REDUCTIONS OBTAINED WITH GAMMA DETECTORS BY USE OF MASSIVE COSMIC-RAY SHIELDING. Kaye, J. H.; Brauer, F. P.; Connally, R. E.; Rieck, H. G. (Battelle-Northwest, Richland, Wash.). Nucl. Instrum. Methods; 100: No. 2, 333-48(1972).

A counting facility has been established 110 m below the top of Grand Coulee Dam to investigate the effects of massive concrete and water cosmic-ray shielding on gamma detector backgrounds. Curves are presented which show that backgrounds at this facility are greatly reduced compared with surface values. Both mercury and special lead shielding have been explored as a means of further reducing the background, and have been found to yield significant improvement at low energies. Detector systems evaluated include NaI(Tl) anticoincidence shielding and two-parameter NaI(Tl) detectors. (auth)

33406 SUBNANOSECOND TIMING WITH A PLANAR Ge(Li) DETECTOR. Bengtson, B.; Moszynski, M. (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 100: No. 2, 293-300(1972).

The shape distribution of charge pulses obtained by uniform γ-irradiation of a 0.25 cm^3 planar Ge(Li) detector with a surface barrier window was studied. Leading-edge time resolution curves obtained with a plastic scintillation counter as time reference showed a strong Ge(Li) late tailing effect which was only partially reduced by the rise time compensation due to Chase. For a combination of the latter method and pulse shape selection time resolution curves were studied for different fractional numbers of all full energy events. By using about one half of all events the Ge(Li) late slope was improved one order of magnitude. For the 511 keV annihilation γ-ray from ^{22}Na a fwhm time resolution of 1.1 ns and a Ge(Li) late $T_{1/2}$ slope of 0.13 ns over more than three decades were obtained. The time resolution was studied for different energies. The interaction number percentage by total absorption for some energies are calculated and the influence on the pulse shape is discussed. (auth)

33407 SHAPE DISTRIBUTION OF PULSES FROM A PLANAR Ge(Li) DETECTOR STUDIED BY A DIFFERENTIAL PULSE-SHAPE SELECTION METHOD. Moszynski, M.; Bengtson, B. (Univ. of Aarhus, Denmark). Nucl. Instrum. Methods; 100: No. 2, 285-91 (1972).

The shape distribution of charge pulses generated by γ-rays has been studied for a planar Ge(Li) detector with a surface barrier window. By a so-called differential pulse-shape selection method, it was possible to extract almost the individual shapes. In contrast to what is expected when a constant electric field distribution is assumed, the observed pulses had a slow and different initial rise. The distribution of electron velocity and electric field in the detector were estimated from the shape of pulses generated by β particles. It showed an inhomogeneous distribution of the electric field, which is very low near the detector window. A study of the delay distribution at 50% of the height of pulses due to β-rays and γ-rays (Compton and full-energy pulses) showed that the slow-rising pulses are generated in the low electric region and that they were not connected with a loss of charge. (auth)

33408 GAS MIXTURE FOR MULTI-WIRE CHAMBERS WITH HIGH PROPORTIONAL GAIN. Fuzesy, R. Z.; Jaros, J.; Kaufman, L.; (and others) (Univ. of California, Berkeley). Nucl. Instrum. Methods; 100: No. 2, 267-8(1972).

A gas mixture ($Ar-Xe-CO_2$) for multiwire proportional chambers which increases the maximum gain that can be reached with full proportional operation is described. (auth)

33409 AUTOMATIC SYSTEM FOR COUNTING ETCHED HOLES IN THIN DIELECTRIC PLASTICS. Congel, F. J. (Macalester Coll., St. Paul); Roberts, J. H.; Dreis, D.; (and others). Nucl. Instrum. Methods; 100: No. 2, 247-52(1972).

The rapid determination of track densities in dielectric plastics is desirable for many experiments. A fast spark discharge counting system similar to that described by Cross and Tommasino has been built for use with thin polycarbonates exposed to fission fragments. Experimental details concerning construction, calibration, and use of this system are discussed and the accuracy of the system is evaluated. An efficiency of about 80% was determined for this apparatus. This system is very useful in investigations where track densities less than 100 tracks/cm^2 are encountered and where a reproducibility of ±10% is acceptable. (auth)

33410 CORRELATION MEASUREMENTS OF NEUTRON-INDUCED MULTIPARTICLE REACTIONS IN NUCLEAR EMULSIONS. Antolkovic, B. (Inst. Ruder Boskovic, Zagreb). Nucl. Instrum. Methods; 100: No. 2, 211-16(1972).

A procedure of using nuclear emulsions in complete measurements of three-body breakup reactions is described. The method allows simultaneous detection of almost the whole momentum space. Owing to the large detection efficiency, the correlation measurements of neutron-induced breakup reactions have become feasible. The data on the three-body breakup of some light nuclei are analyzed in the frame of the Dalitz diagrams in order to extract information on the reaction mechanisms involved. (auth)

33411 DESIGN AND PERFORMANCE OF AN ARRAY OF PLASTIC SCINTILLATORS FOR DETECTING NEUTRONS OF 1.0 TO 450 MeV. Elfield, M. (Ohio State Univ., Columbus); Miller, E. L.; Reay, N. W.; (and others). Nucl. Instrum. Methods; 100: No. 2, 237-42(1972).

The design and performance of an array of plastic scintillator neutron counters are discussed. The array uses counters of three sizes to detect neutrons of 1.0 to 450 MeV, measuring their energy by time-of-flight and their production angles by counter identification and end-to-end timing. Information from 180,000 neutron—proton charge exchange events is used to investigate the resolution stability and internal consistency of the system. Neutron pulse height distributions for narrow bins of neutron energy between 1.25 and 313 are presented and compared with the predictions of a Monte Carlo program. (auth)

33412 APPARATUS FOR MAKING VISIBLE INVISIBLE RADIATION. (to AGA Aktiebolag). British Patent 1,273,778. 10 May 1972. Priority date 30 May 1968, Netherlands.

A modified spark chamber is described in which the anode and auxiliary electrode are separately fastened by metal rings in such a way that the required high precision in the distances between electrodes is maintained. Advantages of this invention include a sharp image, ease of cleaning, resistance to spark discharges, and high efficiency (resulting in short measuring time). (5 figures) (R.W.R.)

33413 SUBATOMIC PARTICLE DETECTOR WITH LIQUID ELECTRON MULTIPLICATION MEDIUM. Alvarez, Luis W.; Derenzo, Stephen E.; Muller, Richard A.; Smits, Robert G.; Zaklad, Haim (to United States Atomic Energy Commission). U. S. Patent 3,659,105. 25 Apr 1972. Filed 21 Oct 1970.

A subatomic particle detector having a large number of equally spaced anode conductors arranged in a single plane opposite and parallel to a large cathode plate with the space between the anode conductors and cathode plate filled with liquid argon is described. A phototransistor is connected to each conductor for automatic readout of the detector by means of a laser beam that is scanned over each phototransistor. (7 figures) (auth)

33414 RADIATION SCANNING DEVICE FOR DETECTING A PLURALITY OF DIFFERENT RADIATING SOURCES POSITIONED IN DIFFERENT PLANES. Cassen, Benedict (to Univ. of California). U. S. Patent 3,659,103. 25 Apr 1972. Filed 4 Aug 1969.

A radioisotope detection system is described in which signals emitted by radioactive particles disposed at different depths in a body under observation are collimated in separate collimating channels which are scanned rectilinearly over the body and whose axes are distributed over a solid angular range. The signals from the individual collimating channels are separately stored in a memory system, such as on different channels on a magnetic tape. The signals recorded in the different channels may subsequently be played back with an adjustable relative time relationship, and the various signals may be controllably superimposed on one another so that the radioactive elements in any plane in the body under observation may be selected for display and study, or a three-dimensional display may be exhibited. (6 figures) (auth)

33415 PROCEEDINGS OF THE SECOND SYMPOSIUM ON SEMICONDUCTOR DETECTORS FOR NUCLEAR RADIATION, HELD AT MUNICH, SEPTEMBER 6–9, 1971. Keil, G.; Brent, H. (eds.). Nucl. Instrum. Methods; 101: No. 1, 1-181(1972). (CONF-710930).

Separate abstracts were prepared for the 27 papers presented. (W.H.K.)

For abstracts of individual papers see: 33416—33432, 33453, 33466—33473, and 33527.

33416 BEHAVIOUR OF LITHIUM IN SILICON. Guislain, H. J.; Schoenmaekers, W. K.; DeLaet, L. H. (Metallurgie-Hoboken-Overpelt, Olen, Belgium). Nucl. Instrum. Methods; 101: No. 1, 1-9(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

Li drift and precipitation was examined in conjunction with other electrical and ir-optical measurements for a wide variety of crystals grown and/or annealed under different conditions. Abnormal behavior of dislocation-free material is analyzed in terms of vacancy concentration and clustering. (auth)

33417 QUALITY CONTROL OF p-TYPE AND INTRINSIC Ge MONOCRYSTALS FOR γ-RADIATION DETECTORS. Delaet, L. H. (Metallurgie Hoboken-Overpelt, Olen, Belgium); Schoenmaekers, W. K.; Guislin, H. J.; Meeus, H. Nucl. Instrum. Methods; 101: No. 1, 11-17(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

Among different measurements on p-type crystals, special attention is given on PCD lifetime as a function of temperature. The lifetime can tell something about the capture cross-section for electrons of multilevel impurities, and also about the leakage current of the Li-diffused Ge diodes. For intrinsic Ge crystals a photocurrent measurement is described as an important tool for the evaluation of the quality (homogeneity). To determine the number of impurities in these crystals, Hall and resistivity measurements down to liquid He temperature are discussed. (auth)

33418 TRAP PARAMETERS OF Ag, Co, Cr, AND Te IMPURITIES IN Ge(Li) DETECTORS. Henck, R. (Centre de Recherches Nucleaires, Strasbourg); Siffert, P.; Schoenmaekers, W. K.; DeLaet, L. H. Nucl. Instrum. Methods; 101: No. 1, 19-22(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

Specially grown Ge crystals containing controlled quantities of various deep-level impurities have been studied. Measurements are done on dislocation-free samples as well as on Ge crystals with dislocations. The trap parameters in the detectors fabricated from these materials were determined using collimated beams of γ-rays. (auth)

33419 LARGE BANDGAP MERCURY AND LEAD COMPOUNDS FOR NUCLEAR PARTICLE DETECTION. Willig, W. R. (Siemens Research Labs., Erlangen, Ger.). Nucl. Instrum. Methods; 101: No. 1, 23-4(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

Research has been done on mercury and lead compounds with emphasis on better detection efficiency (due to higher absorption coefficients) and room temperature application (due to large bandgaps). Crystal growth and detection properties were studied. PbO and PbI_2 were used as alpha particle spectrometers (resolution about 30%) and as gamma quanta detectors (no resolution). HgI_2 was used as a gamma spectrometer (resolution about 10%). (auth)

33420 SEMITOROIDAL DETECTOR CONFIGURATION FOR LARGE (WELL-TYPE) Ge(Li) DETECTORS. Suominen, P. (Univ. of Jyvaeskylae, Finland). Nucl. Instrum. Methods; 101: No. 1, 25-30(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

A "semitoroidal" detector configuration intended for making large Ge(Li) detectors with approximately homogeneous electric fields is described in detail. Test measurements have been carried out with a relatively small semitoroidal detector. The performance of the semitoroidal detector having a volume of more than 150 cm^3 is discussed. (auth)

33421 ION IMPLANTED HIGH-PURITY GERMANIUM DETECTORS. Herzer, H. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Kalbitzer, S.; Ponpon, J. P.; Stuck, R.; Siffert, P. Nucl. Instrum. Methods; 101: No. 1, 31-7(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

Low energy boron and phosphorus ions have been used to implant a p^+-i-n^+ structure in germanium with net concentrations of the order of 10^{10} to 10^{11} donors/cm^3. At 77°K, resolutions of better than 20 keV and 30 keV (fwhm) have been obtained with ^{241}Am$-\alpha$ particles incident on the front-(p^+) and back-(n^+) contact, respectively, of the 2 mm thick device. (auth)

33422 ROOM-TEMPERATURE GaAs GAMMA-DETECTORS. Hesse, K.; Gramann, W.; Hoeppner, D. (AEG-Telefunken, Heilbronn, Ger.). Nucl. Instrum. Methods; 101: No. 1, 39-42(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

A preliminary report is given about studies on GaAs for gamma-detectors. The topics mentioned are: growth of suitable material, examination of the material quality, and results with Schottky—Barrier devices on high purity samples. (auth)

33423 LOW-NOISE OXIDE PASSIVATED p^+n SILICON DETECTORS. Keil, G.; Lindner, E. (Technische Univ., Munich). Nucl. Instrum. Methods; 101: No. 1, 43-6(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

Fabrication and electrical properties of small (2.5 mm diam.) silicon detectors are described. By using boron diffusion for producing the p^+n junction the formation of leakage channels under the protective SiO_2 layer is avoided. The effectiveness of a guard ring structure was investigated with a MOS transistor-like gate-controlled geometry. Surface generated currents were found to give only a negligible contribution. The described detectors can be applied as low-noise probes in nuclear medicine and biology. (auth)

33424 TISSUE EQUIVALENT SEMICONDUCTOR DETECTOR FOR IN-VIVO DOSIMETRY. Jacob, G.; Forcinal, G.; Meuleman, J. (RTC, Caen, France). Nucl. Instrum. Methods; 101: No. 1, 51-4(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

A silicon coaxial detector has been developed for in-vivo dosimetry. Its fabrication and characteristics are presented. Special attention is given to the equivalence with tissue. A solution with an Ag filter is proposed and it is shown on a dose rate measurement example that a nearly perfect equivalence to tissue is obtained. (auth)

33425 DEAD LAYERS ON SEMICONDUCTOR DETECTORS FOR CHARGED PARTICLE SPECTROSCOPY. Protic, D.; Riepe, G. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods; 101: No. 1, 55-60(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

Dead layer effects on side entry and thin contact types of charged particle detectors were investigated. Data are given for α- and β-particles with Ge(Li) and Si(Li) detectors. The results obtained for dead layers on side entry Ge(Li) detectors indicate a negligible contribution to 80 MeV charged particle spectra. (auth)

33426 Ge(Li) DETECTORS WITH HIGHLY COMPENSATED INTRINSIC REGIONS. Grahmann, H.; Kalbitzer, S. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods; 101: No. 2, 61-6(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

By use of a sequence of clean up drifts, extending down to temperatures as low as −80°C, extremely well compensated layers of intrinsic germanium have been produced. Net concentrations of the order of 10^7 uncompensated impurities per cm^3 have been obtained. The resulting changes in the device characteristics, backward and forward current vs bias, capacitance vs voltage, and detector resolution, will be reported. The reversibility of this process, i.e. cycling between clean up and warm up treatment, has been investigated. (auth)

33427 SIMPLIFIED PROCEDURE FOR REACTIVATION OF Ge(Li)-DETECTORS. Sever, Y.; Eichinger, P. (Technische Univ., Munich). Nucl. Instrum. Methods; 101: No. 1, 67-71 (1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

A procedure is given for reactivation of deteriorated Ge(Li)-detectors or for improvement of the characteristics of new mounted detectors without opening the cryostat. It consists of warming a mounted detector to room temperature or above it, by forward biasing with the cold finger immersed in liquid nitrogen. When the detector is warm, reverse bias clean up treatments can be performed. Contact problems are discussed. Experimental examples are given together with the estimation of required clean-up time. (auth)

33428 CHARGE COLLECTION FROM THE ENTRANCE WINDOW OF DIFFUSED DETECTORS AND ITS CONTRIBUTION TO ENERGY RESOLUTION. Berg, G.; Heuberger, A.; Bernt, H. (Technische Univ., Munich). Nucl. Instrum. Methods; 101: No. 1, 73-6(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

A quantitive analysis of two contributions to the energy resolution of Si-pn-detectors with internal multiplication is given: 1. incomplete charge collection from the entrance window, 2. dependence of the multiplication factor on the point of absorption of the γ-quantum. These effects limit the usefulness of multiplying detectors to a small energy range. (auth)

33429 SEMICONDUCTOR DETECTOR TELESCOPES FOR MEASURING PROTON ENERGIES UP TO 300 MeV: PROBLEMS AND SOLUTIONS. Eisberg, R. (Univ. of California, Santa Barbara); Ingham, D.; Makino, M.; Cole, R.; Waddell, C. Nucl. Instrum. Methods; 101: No. 1, 85-90(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The major problem in measuring the energy of a medium energy particle in a semiconductor (or scintillation) detector is the high probability that it will experience a nuclear reaction or scattering in the detector material, before it goes through its range and stops. This problem can be solved by dividing the stopping detector into a number of laminae, measuring the pulse height produced by each lamina, and comparing with predictions obtained from integrations of the range-energy relation. Results obtained in using such a technique with 45 MeV protons are presented, and considerations involved in extending the technique to 300 MeV protons are discussed. (auth)

33430 DETECTION OF HIGH ENERGY PROTONS BY Ge(Li) COUNTERS. Dorcioman, D. (Centre de Recherches Nucleares, Strasbourg); Bertini, R.; Hage-Ali, M.; Siffert, P.; Stab, L. Nucl. Instrum. Methods; 101: No. 1, 91-6(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The problems related to the detection of high energy particles in a semiconductor counter are discussed. Experimental results obtained with 160 MeV protons from the Orsay synchrocyclotron are shown. For an estimated beam straggling of 240 keV, the energy resolution measured with a coaxial Ge(Li) counter was 290 keV ($\simeq 2 \times 10^{-4}$). A scanning over the sensitive volume of the detector with these protons has shown no uncompensated zones. (auth)

33431 USE OF A SEMICONDUCTOR TELESCOPE FOR THE DETECTION OF LIGHT RECOILING NUCLEI IN COHERENT ELASTIC SCATTERING EXPERIMENTS AT HIGH ENERGY. Brossard, M. (Univ., Clermont-Ferrand, France); Combe, J.; Fain, J.; (and others). Nucl. Instrum. Methods; 101: No. 1, 107-11(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The use of semiconductor telescopes to detect, to identify and to measure the energy of the recoil nucleus in proton—nucleus coherent interactions at 600 MeV is described. Preliminary results are obtained using ^{3}He and ^{4}He gaseous targets with a pressure of one atmosphere. (auth)

33432 DERIVATION OF FAST TIME MARKING SIGNALS FROM SILICON SURFACE BARRIER DETECTORS. Vogler, F.; Hofmann, A.; Philipp, G.; Thomas, K. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 101: No. 1, 167-70(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The timing behavior of charge and current pulses from silicon surface barrier detectors was investigated. The current pulses have been derived from a fast current amplifier, which was mounted between the front contact of the detector and ground. Time marking signals were produced by leading edge or constant fraction of pulse height triggering, respectively. The results using the current pulses are compared with those using charge pulses. (auth)

33433 VA-Z-523 GAS-FILLED INTERFERENCE COUNTER. Thiemt, K. (Technische Univ., Dresden). Isotopenpraxis; 8: No. 2, 57-60(Feb 1972). (In German).

The VA-Z-523 interference proportional counter was used to determine tritium in the gaseous phase. Using pentane as counter gas and 10^4-fold external amplification yields plateaus having a length from 600 to 800 V and a slope of 3 percent/100 V. Operating voltage together with pentane pressure shows linear increase by about 4 V/torr. For the background without shield 50 pulses per minute have been recorded with gas pressure being 100 torr and voltage amounting to 2,400 V. Presence of air in the counter gas makes the plateau plots degenerate. With more than 3 percent of air being in the counter, no more plateau is being formed. (auth)

33434 CALCULATED GEOMETRIC FACTORS FOR A WHOLE-BODY RADIOACTIVITY COUNTER. Varentsov, Yu. M. Novosti Med. Priborostr.; 1: 68-76(1970). (In Russian).

The geometry of measurement by radioactivity detectors was the subject of a study in connection with whole body scanning for humans. Values of the geometric factor of a counter with potential use in dose selection were computed as a function of the diameter of the detector and arranged in tabular form. The variables in the array of data are: detector diameter (from 5 to 20 cm), coordinate x of a point source (from 0 to 1 m, in steps of 10 cm), and coordinate z of the point source (0 to 2 m, in steps of 10 cm). (K.S.W.)

33435 ANALYSIS AND CORRECTION OF SPATIAL DISTORTIONS PRODUCED BY THE GAMMA CAMERA. Spector, Steve S.; Brookeman, Valerie A.; Kylstra, Chester D.; Diaz, Nils J. (Univ. of Florida, Gainesville. Veterans Administration Hospital, Gainesville, Fla.). J. Nucl. Med.; 13: No. 5, 307-12(May 1972).

Spatial distortions introduced to radionuclide images from a gamma camera/PDP-8/I computing system have been investigated by analyzing the response of the system using a 4,000-hole technetium collimator to a defined orthogonal grid source of ^{99m}Tc. The 50 × 50 data matrix of the grid image was first corrected for nonuniform sensitivity response, and the nonlinearities in the image were analyzed using programs developed for an IBM 1800 computing system. Spatial distortions ranged from −7.8 to 5.8 mm with 30% of the data matrix points distorted more than 3.2 mm. Spatial errors were consistent, both in magnitude and location, over the camera face during a 5-month period. A software routine has been developed for the IBM 1800 which either shifts each data point in any radionuclide image to its correct location, leaving the count content unchanged, or, leaving each data point in its original position, calculates the correct number of counts for the location in question. The latter alternative maintains the uniform intervals between the digitized data points and hence is more convenient for display of clinical data by an output device. These techniques may be applied to any digitized clinical image to correct for spatial distortions. (auth)

33436 PRACTICAL METHOD FOR THE IDENTIFICATION OF INDIVIDUAL RADIONUCLIDES IN CASES OF SUPERFICIAL CONTAMINATION. Conte, Leopoldo; de Martini, Maria L.; Rimoldi, Ennio (Univ., Milan). Radiol. Med.; 57: No. 5, 377-81(May 1971). (In Italian).

A discriminator was employed to determine spectrum amplitude integrals as a function of the threshold value for pulses generated in a thin plastic scintillation counter by beta particles and electrons emitted by superficial contamination samples obtained by means of the smear test. The curves or, more simply, the threshold values, which reduce the counting frequency to 1%, can be used in the identification of individual radionuclides. (auth)

33437 NUCLEAR RADIATION MONITORING DEVICE WHEREIN A DETECTOR, A REMOTE SOURCE, AND A MEASURING DEVICE ARE CONNECTED BY A SINGLE CABLE. Maillot, Jean-Paul (to International Standard Electric Corp.). U. S. Patent 3,657,540. 18 Apr 1972. Priority date 4 Oct 1968, France.

A nuclear radiation monitoring device wherein a detector and a remote source and measuring device are coupled by a single coaxial cable via a resistor is described. The detector includes a Geiger—Muller counter tube, a low-to-high dc voltage converter, a pulse shaper and a monostable pulse repeater. The remote source supplies a low dc voltage which is converted to a high dc voltage for use by the detector. Signal pulses from the detector reach the remote measuring device substantially without alteration due to the aforementioned resistor which is chosen to have an impedance equal to the characteristic impedance of the coaxial cable. (auth)

33438 ASSORTMENT OF DETECTION ELEMENTS, PROBES, DETECTION UNITS, AND ELECTRONIC BLOCKS OF THE NUCLEAR INSTRUMENTATION RESEARCH INSTITUTE. Novakova, O. (Vyzkumny Ustav Pristroju Jaderne Techniky, Premysleni, Czech.). Radioisotopy; 13: No. 1, 5-19(1972). (In Czech).

A survey is presented of the technical characteristics of detectors, probes, detection units and accessories for detection devices produced by the Nuclear Instrumentation Research Institute. (auth)

33439 RADIO-ISOTOPE SCANNING MACHINE FOR MORE CLEARLY REPRESENTING CONTOURS OF EQUAL RADIATION INTENSITY. Sear, Reginald; Dean, Peter Mervyn (to National Research Development Corp.). U. S. Patent 3,655,973. 11 Apr 1972. Priority date 19 Jun 1968, Great Britain.

A radioisotope scanning machine which provides a photoscan of a field of interest which contains contour lines representing levels of equal intensity of radiation is described. Between each contour line the density of the display can vary from zero to a maximum, or alternatively, the photo display can vary from zero to a maximum throughout the full range of measured intensity of radiation and regions of low or zero density can be introduced at predetermined levels. (auth)

33440 ANALOG WINDOW APPARATUS FOR SIGNALLING WHETHER A DATA POINT REPRESENTED BY A PAIR OF COORDINATE SIGNALS IS WITHIN A SELECTABLY SHAPED REGION OF TWO-DIMENSIONAL SPACE. Lucchesi, Oreste J. (to Nuclear-Chicago Corp.). U. S. Patent 3,655,974. 11 Apr 1972. Filed 23 Jun 1969.

An analog window apparatus for use with Anger-type scintillation camera or the like is described. Two phase-related sinusoidal waveforms of the same frequency determine an analog window of a shape dependent upon the phase relationship. Two comparison circuits receive coordinate signals and the sinusoidal waveforms and register output indications when the amplitudes of the waveforms exceed the amplitudes of corresponding coordinate signals. A gate and hold circuit registers an output when coincident output indications are received at some instant during a comparison period lasting at least one period of the waveforms. (auth)

Radiation Dosimeters

Refer also to abstracts 35204, 35205, and 35208.

33441 (IEA—252) THERMOLUMINESCENT RESPONSE OF NATURAL BRASILIAN FLUORITE TO ^{137}Cs GAMMA-RAYS. Watanabe, S.; Okuno, E. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Nov 1971. 11p. Dep. NTIS (U. S. Sales Only).

Thermoluminescent response of natural Brazilian fluorite to ^{137}Cs gamma-rays was studied, having in mind both the understanding of the supralinearity phenomenon and the utilization of this fluorite in radiation dosimetry. Virgin fluorite was pre-annealed at 580°C for ten minutes followed by 400°C for two hours and then irradiated to different exposures between 25 R and 1.2 MR. The response of glow peak II (pan temperature 180°C) is linear up to 3 kR, beyond which it becomes supralinear and finally saturates at about 300 kR. Under these conditions, the response of glow peak III (pan temperature 290°C) is not supralinear, and saturation is reached sooner, at about 100 kR. The correlation between supralinear response and sensitization was also studied. Samples irradiated to different exposures, as above, were individually annealed after irradiation for 15 minutes at 400°C and then exposed to 100 R. Peak III exhibited sensitized response above 3 kR previous exposure, whereas peak II demonstrated only slight sensitization, and then only near 100 kR previous exposure. Thus, sensitization is anti-correlated with supralinear response for these two peaks. Peak II was found to be sensitized, however, when the post-irradiation anneal was at 175°C instead of 400°C, and thus eliminated only peaks I and II, not I, II and III. Also supralinear response can be obtained from peak III when the virgin phosphor is annealed at 600°C for times longer than 10 minutes. These results are qualitatively explained by the model postulating competing traps, although this model must be applied in a slightly altered form. Other existing models do not seem appropriate. (auth)

33442 DETECTION OF ENERGETIC HEAVY IONS. Katz, R.; Sharma, S. C.; Homayoonfar, M. (Univ. of Nebraska, Lincoln). Nucl. Instrum. Methods; 100: No. 1, 13-32(1972).

The delta-ray theory of track structure, applied earlier to such 1-or-more hit detection systems as the inactivation of dry enzymes and viruses, the NaI(Tl) scintillation counter, and nuclear emulsion, is extended to the silver activated phosphate glass dosimeter, the LiF thermoluminescent dosimeter, the creation of free radicals in solid biological substances, solid and liquid organic scintillators, and the ferrous sulfate (Fricke) dosimeter. The response of these systems to both gamma-rays and heavy ions is characterized by two parameters: (1) D_γ^{37}, the dose of gamma-rays at which 37% of the sensitive elements remain unaffected by the radiation, and (2) a_0, the physical radius (or the exciton diffusion length, or the range of short-range order) of the sensitive element. The decline of detector response with increase in the stopping power of the bombarding ion and the non-linearity of the detector response are characteristic properties of 1-hit detectors, and are most pronounced for the most sensitive detectors. Explicit information about the cross-sectional area of the sensitive target cannot be gained from measurement of the activation cross-section as a function of the stopping power of the incident ion, for there is no saturation cross-section for 1-hit detectors. Since parameters describing the incident ion and those describing the detector are not separable variables, the response of a detector cannot be described through a product of two factors, one containing only ion parameters and representing "radiation quality", and the other containing only detector parameters and representing "detector quality." (33 references) (auth)

33443 IMPROVEMENTS IN AND RELATING TO DOSIMETRY. Oonishi, Hajime; Yamamoto, Osamu; Yamashita, Tadaoki; (and others). (to Matsushita Electric Industrial Co. Ltd.). British Patent 1,272,811. 3 May 1972. Priority date 20 Aug 1968, Japan.

A thermoluminescent dosimeter readout system using a hot gas stream for dosimeter heating is described. (W.H.K.)

33444 RECENT IMPROVEMENTS IN FLUORO-GLASS DOSIMETER. Yokota, Ryosuke (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Oyo Butsuri; 40: No. 12, 1292-1307 (Dec 1971). (In Japanese).

A review is given on recent progress in silver-activated phosphate glass dosimeters. The trapezoidal shape of the glass and its cell combined with a suitable holder greatly improves the dosimeter energy response to β-rays and to x-rays down to 20 keV. The glass dosimeter response to thermal and fast neutrons is described. Fast neutron dose can be measured from the Cherenkov radiation intensity due to the ^{31}P(n,p)^{31}Si reaction in the glass. An improved spherical capsule makes the glass response independent of photon energy and direction. A standard glass washing method and the increase of mechanical and chemical stability of the dosimeter glass are described. With a scanning method, the energy and direction of incident radiation can be measured. A simplified scanning method for glass encased in a spherical capsule is described. Glass encased in a half spherical capsule serves for reading the dose of frontal or backward radiation at critical organs by the scanning method. Good performance glass dosimeters for routine personnel dosimetry and long-term environmental monitoring are described. (auth) (Japan)

33445 THERMOLUMINESCENCE AND ITS APPLICATIONS IN REACTOR ENVIRONMENTS. Gayton, F. M.; Harvey, J. R.; Jackson, J. H. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 2, 125-40(Apr 1972).

The history of thermoluminescence and its development for radiation dosimetry are described. The research undertaken to reveal the proper nature of thermoluminescence and the efforts to improve on the naturally occurring phosphors are reviewed. The flexibility of radio-thermoluminescent devices is demonstrated by the number of applications in health physics and reactor measurements, which are reviewed. (79 references.) (auth) (UK)

33446 THEORY OF WALL-EFFECTS IN MICRODOSIMETRIC MEASUREMENTS. Kellerer, A. M. (Columbia Univ., New York). Contract AT(30-1)-2740. pp 45-53 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Microdosimetric data and the experimental assessment of radiation quality are based upon measurements with proportional counters. The simulation of microscopic tissue regions by cavities filled with tissue equivalent gas is, however, limited by the fact that scaling relations are not preserved when a particle track has multiple intersections with a boundary between regions of different density. This limitation has forced various attempts to replace conventional proportional counters with wall-less constructions. In spite of its practical importance to microdosimetry there is as yet no satisfactory analysis of the problem. General theorems which allow a quantitative determination of the wall-effects can, however, be derived. First one can extend Fano's theorem from a statement on the fluence spectrum at a point to a statement on the spectrum of track segments in extended domains. As a second step one can then evaluate those changes in the statistical correlation of track segments which are brought about by density variations in the irradiated medium. Finally one can give a generalization of Gauchy's theorem on the mean chord length in convex bodies to curved and finite tracks and their secondaries. These results make it possible to assess the differences between energy deposition spectra in conventional counters and wall-less instruments. (auth)

33447 MICRODOSIMETRY OF LOW-ENERGY ELECTRONS. Green, A. E. S.; Olivero, J. J.; Stagat, R. W. (Univ. of Florida, Gainesville). pp 79-97 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Considered from a microscopic viewpoint are the physical processes involved in energy deposition by secondary electrons from many types of primary radiations, e.g., x-rays, electrons, protons, etc. The local spatial and energy distribution of these intermediate electrons plays major roles in the ultimate action of a variety of initial radiations. The state of knowledge of electron impact excitation, ionization, and dissociation cross sections is summarized giving particular attention to the effort at the University of Florida. This effort has been based upon semi-empirical modifications of the Born approximation which provides reasonable extrapolations into the important low-energy region. The modifications were arrived at on the basis of experimental— theoretical analyses of simple systems. Using these cross-section generating techniques the important excitation, dissociation, and ionization cross sections for water vapor are identified. These cross sections are used to calculate the percentages of the initial electron energies which are immediately deposited along the tracks of the primary, secondary, and tertiary etc., electrons into various excitation states, ionization modes, and decomposition products. The results are intended to assist in the fundamental interpretation of the chemical and biophysical processes in radiolysis. (auth)

33448 PHOTOGRAPHIC DETERMINATION OF THE DOSE RATE AROUND A CROWE PROBE. Garsou, J.; Boniver, R. (Univ., Liege). pp 119-26 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Gevaert-Agfa Structurix D_2 films coated with a single-layer emulsion were irradiated in polystyrene and Plexiglas around a Crowe probe and a tube containing 50 mg of radium filtered by 1 mm of platinum, over a range of thicknesses from contact with the radium-bearing equipment to a distance of 10 cm. It was found that: (1) The response of the film to the delivered dose is linear up to an optical density of 2 units for a distance less than 5 mm as well as one between 4 and 10 cm; (2) the absorbed dose-rate in polystyrene is about 6.2 rad/min per mg of Ra at the surface of the Crowe probe, and 0.88 rad/min per mg of Ra at the surface of the radium tube; (3) The range of the beta radiation emitted from the Crowe probe is 9 mm in the Plexiglas (or 10.6 mm in water), the range being measured from the axis of the source; and (4) the ratio between the optical densities measured around the Crowe probes and the radium tube is 1.14 for a thickness of 9 to 11 mm of Plexiglas from the axis of the sources. (auth)

33449 TISSUE-EQUIVALENT PROPORTIONAL COUNTERS IN MICRODOSIMETRY. Belonogii, P. N.; Ivanov, V. I.; Kuz'min, E. S.; Pitkevich, V. A.; Tibanov, A. P. (Moscow Engineering-Physics Inst.). pp 139-68 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The tissue-equivalent material and the design features of a "chromosome" counter and of spherical, needle-type, and cylindrical tissue-equivalent proportional counters are described. Some experimental results are given together with an indication of possible ranges of use of the counters. The path-length distribution for a cylinder of various proportions and the distribution of energy losses in the layers of tissue-equivalent material of different thicknesses are obtained by calculations. (auth)

33450 SEMICONDUCTOR SCINTILLATION DETECTOR FOR THE DOSIMETRY OF X-RAY AND GAMMA-RADIATION. Fietz, J. (Technische Univ., Dresden). Isotopenpraxis; 8: No. 1, 10-13 (Jan 1972). (In German).

Combination of suitable CdS photoresistors with long-wave fluorescent organic plastic scintillators renders possible production of miniature scintillation probes with low energy dependence for the dosimetry of x and gamma radiation. The probe described comprises a CL 905 HLL type photoresistor for scintillation light measurement and a polystyrene scintillator with luminescent components PBD and PNB (λ_{max} = 493 nm) as a radiation detector. The construction and properties of a semiconductor scintillation detector having a range of measurement from 1 to 1000 R/h are described. Measures providing reduction of energy dependence of the probe indication are emphasized. (7 figures) (auth)

33451 METHOD AND APPARATUS FOR DETECTING X-RAY RADIATION USING A CHOLESTERIC DETECTOR. Fergason, James L.; Goldberg, Newton N. (to Westinghouse Electric Corp.). U. S. Patent 3,657,538. 18 Apr 1972. Filed 22 Aug 1968.

Increasing dosages of x radiation progressively lower the colorplay range of cholesteric-phase liquid-crystal materials. The effect is enhanced when an effective amount of an iodine-containing compound is used in the liquid-crystal material. Novel iodine-containing compounds are described, and articles are disclosed that give direct-reading indication of the dosages of x radiation that they have received without need for a separate development operation. (2 figures) (auth)

33452 PARAMETERS AFFECTING THE RADIATION-INDUCED THERMALLY STIMULATED EXOELECTRON EMISSION FROM CERAMIC BERYLLIUM OXIDE. Crase, Kenneth Wayland. Knoxville, Tenn.; Univ. of Tennessee (1971). 104p. University Microfilms Order No. 72-15,513.

Thesis.

The potential applications in radiation dosimetry of the thermally stimulated exoelectron emission (TSEE) from a number of materials were investigated, and efforts were made to optimize their dosimetric properties. A commercial ceramic BeO is the most promising. It has a three-peak emission spectrum, with a dominant peak at ~325°C, and two smaller peaks at ~450 and ~535°C, respectively. Changes in the sensitivity of the main peak following different heat treatments and chemical etchings were related to the presence and state of silicon in the surface region. It is suggested that Si^{4+} substitutes for Be^{2+} and acts as an electron trap. BeO was also bombarded with more than 10^{10} rad of deuterons, bringing about dramatic changes in its TSEE spectrum;

the ~450°C peak is greatly enhanced by such bombardment, while the ~325°C peak is obliterated by intense localized heating. The radiation response characteristics of pretreated ceramic BeO were studied for alpha, beta, and gamma radiations. The main peak saturates at doses of approximately 1×10^5 and 2×10^4 rad for beta and gamma radiations, respectively, but no well-defined saturation was observed for alpha radiation up to 10^5 rad. A shift of the ~325°C TSEE peak temperature with increasing doses may be related to the energy width of the trapping level. The energy dependence of the electron response is shown to vary roughly as the electronic stopping power in the range 1 to 20 keV. Doses of less than 0.1 mrad can be measured. Pairs of BeO detectors, only one being covered by a hydrogenous material, are suitable for highly sensitive and fairly energy-independent fast-neutron measurement in mixed radiation fields. The incorporation of these dosimeters into a personnel dosimetry badge is discussed. (Diss. Abstr. Int., B)

33453 Si-PHOTODIODES AS DOSIMETERS FOR FAST NEUTRONS. Roesch, E.; Weickelt, G.; Brostroem, D. (AEG-Telefunken, Heilbronn, Ger.). Nucl. Instrum. Methods; 101: No. 1, 47-9(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The dosimeter properties of Si-photodiodes, e.g., dose sensitivity, detection limit (1 rad), temperature dependence of photocurrent at different doses, have been investigated. The evaluation equipment is described and further improvements are discussed. (auth)

33454 DEMANDS TO BE MET BY A MODERN EXTERNAL EXPOSURE MONITORING DEVICE. Spurny, Z. (Inst. of Nuclear Research, Prague). Isotopenpraxis; 8: No. 2, 53-7(Feb 1972). (In Russian).

Problems of dosimetric monitoring of external exposure are investigated with regard to technical demands and evaluation of measurement results. Particular attention is given to new methods of personnel monitoring and their further development. (auth)

33455 USE OF CaF_2 THERMOLUMINESCENT DOSIMETERS FOR MEASURING THE NATURAL BACKGROUND RADIATION. Burgkhardt, B.; Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). Kerntechnik; 14: No. 3, 128-34(Mar 1972). (In German and English).

The technical properties of CaF_2 (nat) dosimeters of the type MBLE PNP 090 are described with particular reference to the linearity of the exposure range, the energy-dependence of the exposure readout, the sensitivity to light, the pre-exposure performance, the zero-effect increase owing to internal radiation, and the measurement accuracy in the range up to 0.1 mR, all in the context of using the dosimeters in the open for measuring the natural background radiation level. A comparison with other solid state dosimetry systems shows the particular suitability of CaF_2 dosimeters for measuring the natural background radiation level with a standard deviation of ±5% after an exposure time of 4 days. (auth)

33456 THERMOLUMINESCENT DOSIMETRY READOUT APPARATUS. Bjarngard, Bengt; Webb, Geoffrey A. M. (to Isotopes, Inc.). U. S. Patent 3,657,535. 18 Apr 1972. Filed 5 Jun 1969.

A thermoluminescence dosimetry readout system adaptable to different applications and comprising a basic thermoluminescent dosimetry readout apparatus in which a dosimeter is heated by a strong alternating current to emit thermoluminescent light is described. The light flux is converted to an electric current which is converted to a pulse train. The pulse train is counted by a four decade counter and the result, which is proportional to the integrated signal, is displayed on Nixie tubes. Numerous accessories form part of the system and comprise a thermocouple to contact the heating element during heating for indicating its temperature; recorders to record the light flux and temperature patterns; a printer to print identifications, Nixie displays and peak temperatures; and means for entering the identifications. The accessories may be used in numerous combinations to provide systems for various applications. (auth)

33457 THERMOLUMINESCENCE MECHANISM IN DOSIMETRY LiF. Christy, R. W. (Dartmouth Coll., Hanover, N. H.); Mayhugh, M. R. J. Appl. Phys.; 43: No. 7, 3216-17(Jul 1972).

The high-temperature dosimetry glow peaks in LiF : Mg are thought to result from thermal release of electrons from traps associated with the Mg impurity. There is also evidence, however, that the visible-light emission in the same glow peaks is due to recombination of mobile holes. These observations were reconciled by a mechanism proposed by Mayhugh in which the thermally ionized electron frees a V_3-center hole, which then emits a photon at another recombination center. This model is supported by new measurements of Podgoršak, Moran, and Cameron on glow peaks which occur below room temperature. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 33086 and 34841.

33458 (FEI-251) GAMMA-SPECTROMETER OF HIGH RESOLUTION. Gamalii, A. F.; Gonchar, A. I.; Karyakin, Yu. V.; Nesterov, B. V.; Shchadin, N. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

A high-resolution semiconductor spectrometer is described, and the factors which effect its resolving power are discussed. The associated preamplifier and amplifier are shown in schematic form. Sample spectra from ^{57}Co, ^{60}Co, and an (n,γ) reaction on ^{53}Cr are given. (K.S.W.)

33459 (JINR-P6-6227) PROCESSING OF SPECTRA FROM SEMICONDUCTOR DETECTORS BY SEMIAUTOMATIC SYSTEM CONTAINING STORAGE AND COMPUTERS. Arlt, R.; Winter, G.; Medved, S. V.; Musiol, G.; Sinaev, A. N.; Usmanova, Z. A.; Fromm, D.; Chistov, N. A.; Strusny, H. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Feb 1972. 27p. (In Russian). Dep. NTIS (U. S. Sales Only).

A semiautomatic system consisting of a computer and storage capability was designed for spectra processing from semiconductor detectors. Information from the spectrometric apparatus is recorded in monitoring-storage facilities, and at the conclusion of the exposure, is transmitted to a buffer installation. The latter is equipped with an oscillograph with a light pencil for control, lay-out, and selection of data for further processing. Preliminary processing of information is accomplished by means of a Minsk-22 computer, and final processing is handled in a CDC-1604A. Programs process data from gamma spectra, beta spectra, and spectra from conversion electrons. (tr-auth)

33460 (UCRL-73023) LOW-LEVEL COUNTING WITH SOLID-STATE Ge(Li) DETECTORS. Phelps, Paul L. (California Univ., Livermore. Lawrence Radiation Lab.). 8 Feb 1971. 52p. (CONF-710204-5). Dep. NTIS.

From Symposium on the role of semiconductor detectors in the future of nuclear medicine; Chicago, Ill. (12 Feb 1971).

A review of the operation and characteristics of Ge(Li) gamma spectrometers for low-level counting is given. Resolution and photopeak efficiency, interference from background and Compton radiation, counter shield construction, x-ray fluorescence production, cryostat considerations and signal processing are briefly discussed. Low-level counting results are presented on the analysis of blood serum for ^{57}Co, analysis of rabbit thyroid gland for ^{131}I, analysis of air filter sample for fission product radioisotopes, and analysis of soil for radioisotopes. Also, anticoincidence shielded spectrometers are discussed. (39 references) (auth)

33461 MEASUREMENT OF MeV-RANGE TOTAL CROSS SECTIONS USING REACTOR NEUTRONS. Norman, G. R.; Prestwich, W. V.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 100: No. 1, 77-82(1972).

A new method for the measurement of neutron total cross sections in the energy region 0.8 to 3.0 MeV is described. Use is made of the fast neutron flux of a pool-type reactor and the energy is defined by a time-of-flight spectrometer consisting of a scattering and a subsequent detecting fast organic scintillator. Considerable attention has been focussed upon experimental design with an aim to optimization of both the time resolution and the signal-to-noise ratio. The resolution obtained ranged from 15 keV at 0.8 MeV to 50 keV at 3.0 MeV. The statistical error associated with the cross section was 2% in the central energy region and rose to 10% at the extreme. Typical results are presented for ^{27}Al. (auth)

33462 NUCLEAR LIFETIME MEASUREMENTS USING LOADED SCINTILLATORS. Winyard, R. A.; McBeth, G. W. (Brighton Polytechnic, Eng.). Nucl. Instrum. Methods; 100: No. 1, 125-33(1972).

The use of scintillators loaded with radioactive isotopes in delayed coincidence measurements is discussed. The feasibility of the principle is illustrated by a measurement of the half-life of the $\frac{5}{2}^+$, 86.6 keV level of ^{233}Pa. A half-life of (35.6 ± 0.7) ns was obtained in excellent agreement with previous determinations. The use of pulse shape discrimination to eliminate background is also discussed. (auth)

33463 PROBE FOR NEUTRON ACTIVATION ANALYSIS IN A DRILL HOLE USING ^{252}Cf, AND A Ge(Li) DETECTOR

COOLED BY A MELTING CRYOGEN. Tanner, A. B. (Geological Survey, Washington, D. C.); Moxham, R. M.; Senftle, F. E.; Baicker, J. A. Nucl. Instrum. Methods; 100: No. 1, 1-7(1972).

A sonde has been built for high-resolution measurement of natural or neutron-induced gamma rays in boreholes. The sonde is 7.3 cm in diameter and about 2.2 m in length and weighs about 16 kg. The lithium-compensated germanium semiconductor detector is stabilized at −185 to −188°C for as much as ten hours by a cryostatic reservoir containing melting propane. During periods when the sonde is not in use the propane is kept frozen by a gravity-fed trickle of liquid nitrogen from a reservoir temporarily attached to the cryostat section. A ^{252}Cf source, shielded from the detector, may be placed in the bottom section of the sonde for analysis by measurement of neutron-activation or neutron-capture gamma rays. Stability of the cryostat with changing hydrostatic pressure, absence of vibration, lack of need for power to the cryostat during operation, and freedom of orientation make the method desirable for borehole, undersea space, and some laboratory applications. (auth)

33464 AUTOMATIC PEAK-EXTRACTION TECHNIQUE. Robertson, A.; Prestwich, W. V.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods; 100: No. 2, 317-24(1972).

A simple additive correlation procedure is proposed as a tool in the automatic examination of spectra for peak centroid and intensity information. The capabilities of the technique are illustrated in the analysis of data collected during a study of thermal neutron capture in argon. (auth)

33465 FLEXIBLE BASELINE RESTORER. Bertolaccini, M.; Bussolati, C. (Politecnico, Milan). Nucl. Instrum. Methods; 100: No. 2, 349-53(1972).

A baseline restorer has been developed in which both the restorer time constant and the positive and negative voltage thresholds can be varied independently. This makes it possible to cope better with different experimental situations, thus reaching higher resolving power in nuclear spectroscopy. (auth)

33466 SEMICONDUCTOR DETECTORS FOR CHARGED PARTICLE SPECTROSCOPY IN THE 80 MeV RANGE. Riepe, G.; Protic, D. (Kernforschungsanlage, Juelich, Ger.). Nucl. Instrum. Methods; 101: No. 1, 77-83(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

Considerations concerning essential parameters are followed by a presentation of the experimental set-up. The type of telescope cryostat used for scattering experiments is described, particle (d,t,^{3}He,α) spectra are given, and experience with radiation damage effects is discussed. (auth)

33467 SEMICONDUCTOR X-RAY SPECTROMETERS. Muggleton, A. H. F. (Nuclear Enterprises Ltd., Edinburgh). Nucl. Instrum. Methods; 101: No. 1, 113-25(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

An outline is given of recent developments in x-ray semiconductor detectors. With current techniques, detectors having areas of 25 to 50 mm^2 and a few millimeters thick can be fabricated to give resolutions better than 200 eV. After a brief description of the basic mechanism of semiconductor counter operation a comparison is made between semiconductor counters and gas filled proportional devices. Detector fabrication and cryostat design are discussed in detail. The effects of various device parameters on system performance, such as energy resolution, count rate capability, efficiency, etc., are discussed and steps taken to reduce microphony demonstrated. The main applications of these detectors in x-ray fluorescence analysis, electron microprobe analysis, and scanning electron microscopy are reviewed. (20 references) (auth)

33468 SOME ASPECTS OF X-RAY FLUORESCENCE SPECTROMETERS FOR TRACE ELEMENT ANALYSIS. Landis, D. A.; Goulding, F. S.; Jarrett, B. V. (Univ. of California, Berkeley). Nucl. Instrum. Methods; 101: No. 1, 127-35(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The application of pulsed-light feedback to low energy x-ray spectrometers is discussed with respect to the energy resolution and counting rate performance. The use of a guard-ring detector and appropriate circuits to reduce background counts and thereby enhance the sensitivity of x-ray fluorescence analysis is also discussed. (auth)

33469 USE OF A Ge(Li) TOTAL-ABSORPTION SPECTROMETER IN (n,xγ) MEASUREMENTS. Orphan, V. J.; Hoot, C. G.; John, J. (Gulf Radiation Tech., San Diego, Calif.). Nucl. Instrum. Methods; 101: No. 1, 137-48(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

An 80 cm^3 Ge(Li) detector, sectioned to operate as a total-absorption spectrometer, has been used in (n,xγ) cross-section measurements using the Linac time-of-flight technique. Use of a computer-controlled data acquisition system allowed the detector to be operated simultaneously as an ordinary Ge(Li) detector (singles mode) and as a total absorption spectrometer (Duode mode). Typical operating characteristics of the detector are given and its performance illustrated with examples of gamma-ray spectra from (n,xγ) reactions. The determination of true continuum gamma-ray intensities by unfolding the spectra measured in the singles mode is described and typical results of this Ge(Li) spectrum unfolding are shown. (auth)

33470 USE OF THE SINGLE ESCAPE PEAK IN Ge(Li) SPECTROSCOPY. MacKenzie, I. K.; Campbell, J. L. (Univ. of Guelph, Ont.). Nucl. Instrum. Methods; 101: No. 1, 149-52 (1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The single escape (SE) peak in a Ge(Li) detector is shown to be wider than either a double escape or a full energy peak of the same pulse height. The extra width arises from Doppler broadening of the annihilation energy and is determined by the electron momentum distribution in germanium. In addition the centroid of an SE peak in a coaxial detector is Doppler shifted to higher energies because of the positron's mobility in the electric field in the detector. These effects necessitate caution in the use of SE peaks in energy measurements and system linearity tests, and in extraction of Fano factor or nuclear lifetime from linewidth measurements. (auth)

33471 EFFICIENCY CALIBRATION OF SEMICONDUCTOR X-RAY DETECTORS IN THE ENERGY RANGE 3 TO 200 keV. Campbell, J. L.; McNelles, L. A. (Univ. of Guelph, Ont.). Nucl. Instrum. Methods; 101: No. 1, 153-62(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

New decay data for calibration standards are presented. Measured efficiency curves are discussed in terms of detector properties, and the level of precision attainable is considered in the context of various current applications of low energy photon detectors. (auth)

33472 DECAY MEASUREMENTS OF SINGLE GAMMA RAYS SELECTED BY A DIGITAL DUAL WINDOW. Fettweis, P.; Mies, E. (SCK–CEN, Mol, Belgium). Nucl. Instrum. Methods; 101: No. 1, 163-5(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

A dual digital window for selecting single γ-rays out of a complex Ge(Li) spectrum is described. It is used for decay studies and the establishment of radiogenic relations. A practical illustration is given. (auth)

33473 PULSE SHAPE ANALYSIS IN COAXIAL Ge(Li)-DETECTORS. Belusa, D.; Fretwurst, E.; Jaber, F.; Lindstroem, G. (Univ., Hamburg). Nucl. Instrum. Methods; 101: No. 1, 171-81 (1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The spectrometer performance of a coaxial Ge(Li)-γ-ray detector is studied with respect to the implications given by the charge collection process. Strong correlations between the rise-time distribution and the peak shape and corresponding half width as well as the peak-to-background ratio are found. The application of a pulse shape discrimination method is discussed and the obtained relevant improvements are reported in detail. (auth)

33474 MOESSBAUER SPECTROMETRY WITH MULTIWIRE PROPORTIONAL COUNTERS. Barbero, C.; Bonazzola, G. C.; Bressani, T.; Chiavassa, E.; Musso, A. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Lett. Nuovo Cim.; 4: No. 1, 19-22(6 May 1972).

The principle of operation and preliminary results of a study to design a multichannel Moessbauer spectrometer are given. A multiwire proportional counter and the absorber are in the form of cylindrical surfaces of aperture $\pi/2$ or less with the γ source at the center. The absorber moves relatively to the source, forward and backward with a constant velocity. This setup permits measuring simultaneously the complete velocity spectrum. (W.H.K.)

33475 NUCLEAR INSTRUMENTS IN THE FIGHT AGAINST LEAD POISONING. Isotop. Radiat. Technol.; 9: No. 3, 271-7 (Spring 1972).

Two x-ray-fluorescence instruments that use ^{57}Co or ^{109}Cd as the source of exciting radiation for the determination of lead in paint in situ are described. (9 figures) (auth)

High Energy Physics Instrumentation

Refer also to abstract 34596.

33476 (ANL/HEP–7210) PARAMETERS AND PERFORMANCE CHARACTERISTICS OF THE 12 FOOT BUBBLE CHAMBER. Jaeger, K. (Argonne National Lab., Ill.). Mar 1972. 26p. Dep. NTIS.

The chamber components and dimensions are described including liquid volume, optics system, expansion system, magnet, cryogenics, and the control room. Also, scanning and measuring of the bubble chamber film is discussed, and an overall view of the existing, planned, and contemplated beams for the bubble chamber is shown. (W.H.K.)

33477 (IFVE/SPK–70-110) CALCULATION OF DISTORTIONS IN THE OPTICAL SYSTEMS OF BUBBLE CHAMBERS. Klimenko, S. V.; Mikhailov, O. I.; Rybin, A. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1970. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

A system for taking pictures of a conventional bubble chamber for a general case in the form of a set of poles of conical projection and of a system of refractive surfaces is considered. A real system for taking pictures is considered as a distortion of some ideal system. A structure for transforming the coordinates of a space point image of the bubble chamber operational volume from real into ideal ones is described. (auth)

33478 (ITEF–882) CONCERNING THE ACCURACIES OF MEASUREMENTS IN LIQUID-HYDROGEN BUBBLE CHAMBERS. Kliger, G. K.; Kolganov, V. Z.; Smolyankin, V. T. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1971. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

Problems concerning the accuracy of measurement of momenta and angles of secondary particles and the effective mass resolution of hydrogen bubble chambers are discussed. Two chambers for incident pions at 4 to 10 GeV/c are considered: one chamber is $200 \times 60 \times 40$ cm^3 and H = 20 kG; the other chamber is 150 cm in diameter, 100 cm deep, and H = 70 kG. The production kinematics of secondary particles and the chamber geometry are taken into account. The methods of accuracy improvement and the attainable effective mass resolution in the bubble chambers are considered. (auth)

33479 (KHFTI–70-38) CALCULATION OF TRAJECTORY TRACK OF A CHAMBER PARTICLE BY STEREOPHOTOGRAPHY. Adushkina, R. I.; Vaisfel'd, A. M.; Vatset, P. I.; Koltunov, I. A.; Lyubarskii, G. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

The kinematic parameters of a track were determined by comparing the experimental curves with a family of trajectories obtained by solving an equation of motion. Comparison of the coordinates of points, measured by an operator, with the projection of a particle track in a stereo frame, avoids certain difficulties in trajectory calculations. Formulas are offered for the calculation of tracks by stereophotography, and are used for particle localization by the method of maximum similitude. (tr-auth)

33480 (KHFTI–70-39) SIMULATION OF A CHAMBER EXPERIMENT. Bezruk, A. I.; Vaisfel'd, A. M.; Koltunov, I. A.; Lyubarskii, G. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 9p. (In Russian). Dep. NTIS (U. S. Sales Only).

Mathematical simulation of a chamber experiment offers, among other objectives, verification of a method for determining the kinematic parameters of chamber particles. Algorithms for simulating various aspects of a chamber experiment are advanced, and a method for automation of a technique for reconstructing chamber events is described. (tr-auth)

33481 (KHFTI–70-52) ABSOLUTE MEASUREMENT OF THE INTENSITY OF A HARDENED BREMSSTRAHLUNG BEAM BY A FLUCTUATION METHOD. Lyakhno, Yu. P.; Nikitin, V. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

A fluctuation method using two Cherenkov detectors was evaluated for the absolute measurement of the intensity of hardened bremsstrahlung radiation utilized in bubble chamber experiments. Beams of other particles of intermediate intensity were also measured: intensity larger than that of the elementary particles measured by counters and smaller than the threshold of response of integrating calorimeter devices, quanta meters, etc. Measurements of bremsstrahlung intensity were made by the fluctuation method described. (tr-auth)

33482 USE OF ILFORD K2 NUCLEAR EMULSIONS IN STUDIES OF THE COSMIC RAY CHARGE SPECTRUM. Rosander, R. (Univ. of Lund, Sweden). Nucl. Instrum. Methods; 100: No. 1, 149-55(1972).

Photometric mean track width measurements have been carried out on about 200 primary cosmic ray particles ($5 \leq Z \leq 26$). stopping in an Ilford K2 emulsion stack. The standard deviation of the experimentally determined charge values is about 0.3 units of charge in the whole spectrum, when the residual range interval of 0.5 to 10.5 mm has been used for identification. The resolution compares well with the charge resolution obtained with other types of cosmic ray detectors. (auth)

33483 SIMPLE TWO-DIMENSIONAL SPARK CHAMBER WITH LOW DELAY TRIGGER SYSTEM. Berst, J. D.; Chatelus, Y.; Erickson, E. F. (Paris Univ., Orsay, France). Nucl. Instrum. Methods; 100: No. 1, 173-8(1972).

A simple two-dimensional spark chamber with low delay trigger is described. The application required a resolution of ≈1 mm in one dimension and a resolution of ≈10 mm in the other dimension. Digital and analog readout techniques are combined to obtain the two-dimensional information. The other major requirement for the device was that its sensitive time be short relative to the microsecond spill of an electron linear accelerator. Relative merits and possible uses of the instrument are discussed. (auth)

33484 SOME PROPERTIES OF STACKS OF DISCHARGE CHAMBERS WITH INFINITELY TRANSPARENT ELECTRODES. Charpak, G.; Breskin, A.; Piuz, F. (CERN, Geneva). Nucl. Instrum. Methods; 100: No. 1, 157-64(1972).

It is shown that it is possible to build projection discharge chambers with electrodes infinitely transparent to the light emitted by the discharges. This is achieved mainly by having the wires of the electrodes perfectly aligned either in parallel arrays, or in arrays converging to the objective of the optics. Chambers with almost isotropic properties and many attractive features can thus be built. (auth)

33485 READ-OUT SYSTEM FOR WIRE SPARK CHAMBERS WITH CORE MEMORY. Cevenini, F. (National Inst. of Nuclear Physics, Naples). Nucl. Instrum. Methods; 100: No. 2, 375-8 (1972).

A very simple and compact read-out system for core memory spark chambers is described. It uses a multichannel analyzer as a fast recording device. The reading speed is about 200,000 wires/sec. (auth)

33486 MULTICHANNEL TIME OF FLIGHT RECORDING SYSTEM. Sumner, R. (Univ. of Chicago). Nucl. Instrum. Methods; 100: No. 2, 371-3(1972).

The design and performance of a 30 channel time of flight recording system is described. The system uses an eight trace oscilloscope and photographic recording, in conjunction with an optical spark chamber experiment. (auth)

33487 STREAMER CHAMBER CHARGING REGULATOR SYSTEM. Fuja, R. E.; Dawson, J. W. (Argonne National Lab., Ill.). Nucl. Instrum. Methods; 100: No. 2, 329-31(1972).

In a streamer chamber system being built at Argonne National Laboratory, the specifications for pulse repeatability impose stringent requirements on the Marx generator charging electronics. A charging regulator using type 284 tetrode modulator tubes was developed to provide the required stability. The system philosophy, design requirements, and circuit configuration are discussed. (auth)

33488 METHOD FOR MEASUREMENTS OF COORDINATES EMPLOYING SHOCK WAVES. Dayan, M.; Grinberg, J.; Oren, Y.; Seidman, A. (Tel-Aviv Univ., Israel). Nucl. Instrum. Methods; 100: No. 2, 243-5(1972).

A method of measuring X–Y planar coordinates, using shock waves generated by sparks is proposed. This method is based on the principle of sonic spark chambers but minimizes the errors caused by the inconstancy of the wave velocity. This work is suggested for measurements of coordinates during the scanning of particle tracks photographs and as an improvement in sonic spark chambers. (auth)

33489 ON-LINE COUNTER HODOSCOPE FOR HIGH-ENERGY PHOTOPROTONS. Dougan, P.; Kivikas, T.; Lugner, K.;

Ramsay, V.; Stiefler, W. (Lund Univ., Sweden). Nucl. Instrum. Methods; 100: No. 2, 269-75(1972).

The design and performance of an on-line counter hodoscope for the study of high-energy protons from photon-induced reactions are discussed. (auth)

33490 COMPUTER SIMULATED MODEL FOR DIFFUSION AND DRIFT OF ELECTRONS IN FLASH TUBES. Holroyd, F. W.; Breare, J. M. (Univ. of Durham, Eng.). Nucl. Instrum. Methods; 100: No. 2, 277-80(1972).

A Monte Carlo method is used to solve the equation of diffusion and drift of electrons in a flash tube, taking into account the formative distance of the discharge. Hence the efficiency as a function of delay between the passage of an ionizing particle and the application of the high voltage pulse is found for different electron drift velocities. Comparison of experimental efficiencies with these results enables an estimate to be made of the electric fields built up in flash tubes when they are operated at high repetition rates. (auth)

33491 EDGE PROFILES OF SPARK CHAMBER FRAMES. Breare, J. M.; Lightfoot, J. A.; Stubbs, R. J. (Univ. of Durham, Eng.). Nucl. Instrum. Methods; 100: No. 2, 281-4(1972).

The problem of edge breakdown in spark chambers is considered and is shown to be due to field distortion at the gas dielectric interface. Consideration is given to several edge profiles, made from commonly used materials, which are expected to minimize the field distortion. Results show good agreement with the qualitative theory. (auth)

33492 SENSITIZING MECHANISM OF NUCLEAR EMULSIONS TOWARD IONIZING RADIATION BY p-DIMETHYLAMINOSTYRYL DYES. Bogomolov, K. S.; Razorenova, I. F. Zh. Nauch. Prikl. Fotogr. Kinematogr.; 16: No. 6, 401-4(Nov-Dec 1971). (In Russian).

The mechanism of sensitizing nuclear emulsions toward the action of ionizing radiation was studied using 1-phenyl-3-p-dimethylaminostyrylpyrazole ethyl perchlorate. A ribbon-filament lamp with a blue light filter was the light source for some experiments, and a mercury lamp was used for others. Without the dye, part of the electrons formed as a result of irradiation do not take part in the formation of the latent image. The presence of the dye creates finely-divided unstable traps on which the electrons fall and are captured for some time. Since the energy pocket is not deep, the electrons may be freed and again participate in a photographic process. (K.S.W.)

Radiometric Instruments

Refer also to abstracts 33494, 33554, 34322, and 35352.

33493 INVESTIGATION ON THE RELATIONSHIP BETWEEN DOSE AND ENERGY RESPONSE OF THE PHOTON RADIATION IN FILM DOSIMETRY. Bojtor, I. (National Research Inst. for Radiobiology and Radiohygiene, Budapest). Acta Biochim. Biophys. (Budapest); 6: No. 1, 31-9(1971).

The importance of assessing photon energy in personnel monitoring and its adaptation to photographic dosimetry is stressed. The factors correcting for the changes in film sensitivity were studied, as a function of photon energy, in the 12 to 128 keV range according to Dresel's system. The ratio of blackenings measured at the film under empty field and under lead filter, respectively, was used for the assessment of energies from 130 to 1225 keV. The dose dependence of the relationship was investigated. Suggestions are given for personnel monitoring. (auth)

33494 SEVENTH INTERNATIONAL CHROMATOGRAPHY SYMPOSIUM, LAS VEGAS, NEVADA, NOVEMBER 29–DECEMBER 3, 1971. Anal. Chem.; 43: No. 14, 1921-2070(Dec 1971). (CONF-711120).

Separate abstracts were prepared for 4 of the 23 papers presented. The remaining 19 papers were not sufficiently within the scope of NSA. (W.H.K.)

For abstracts of individual papers see: 33495–33497 and 34322.

33495 GAS-PHASE COULOMETRY BY THERMAL ELECTRON ATTACHMENT. Lovelock, J. E. (Univ. of Reading, Eng.); Maggs, R. J.; Adlard, E. R. Anal. Chem.; 43: No. 14, 1962-5(Dec 1971).

From seventh international chromatography symposium; Las Vegas, Nev. (29 Nov 1971).

With intensely electron-absorbing substances, the electron capture detector tends toward destructive detection in which a large proportion of the substance entering the detector is ionized irreversibly. This tendency can be developed to the point where the detector can function as a gas-phase coulometer. The physical basis, experimental verification, and practical conditions for coulometric analysis with the electron capture detector are discussed. (auth)

33496 ELECTRON CAPTURE DETECTOR: A NEW MODE OF OPERATION. Maggs, R. J.; Joynes, P. L.; Davies, A. J.; Lovelock, J. E. (Pye Unicam Ltd., Cambridge, Eng. Shell Research Ltd., Chester, Eng.). Anal. Chem.; 43: No. 14, 1966-71(Dec 1971).

From seventh international chromatography symposium; Las Vegas, Nev. (29 Nov 1971).

An established electron capture detector was evaluated under a new mode of operation. By means of a suitable power supply, the detector current was held constant while the frequency of the applied pulses was varied. In this way a change of pulse frequency becomes a measure of the concentration of the electron capturing species in the detector. The response was estimated to be linear over a range of about 5×10^4 with a detection limit of approximately 4×10^{-14} gram/ml of Dieldrin. The effects of temperature, reference current level, carrier gas composition, and flowrate on the detector performance were studied. (auth)

33497 HIGH TEMPERATURE TRITIUM SOURCE FOR ELECTRON CAPTURE DETECTORS. APPLICATION TO A LOW VOLUME DETECTOR. Fenimore, D. C. (Texas Research Inst. of Mental Sciences, Houston); Loy, P. R.; Zlatkis, Albert. Anal. Chem.; 43: No. 14, 1972-5(Dec 1971).

From seventh international chromatography symposium; Las Vegas, Nev. (29 Nov 1971).

A tritium ionization source capable of sustained operation at 300°C was evaluated for use in electron capture detectors. The high specific activity of the source permitted utilization of a relatively small source area in a low volume coaxial geometry detector designed for operation at elevated temperatures. Use of this detector at low carrier gas flows associated with capillary columns was demonstrated. (auth)

33498 NEW METHODS FOR MEASUREMENT OF DEW POINT, HUMIDITY, MELTING POINT BY RADIOISOTOPES. Kobayashi, H. (Saitama Univ., Urawa, Japan). Genshiryoku Kogyo; 17: No. 11, 69-72; 80(Nov 1971). (In Japanese).

Though instruments using radioisotopes are already popular, the following new methods to measure dew-point, humidity and melting-point have unique features in their principle of operation. The new methods to measure dew-point and humidity by α-ray absorption, melting-point by change of α-ray absorption, and dew-point by β-ray diffusion are described. The dew-point and humidity can correctly be determined with only a small amount of radioactive sources, and the method is suitable for automation so that this equipment can easily be incorporated into future automatic air-conditioning for buildings, automated meteorological observation systems, or automatic humidity control in production lines. The method to measure the melting-point utilizes the sharp change of the α-ray absorption and has a special feature that only a very small amount of sample is required for measurement. Trial manufacture of these instruments is now undertaken, and their production is expected in the near future. (Japan)

33499 ISOTOPIC PRESSURE TRANSDUCER. Droszcz, Janusz. Pomiary, Automat., Kontr.; 17: No. 8, 350-1(1971). (In Polish).

The design of a pressure transducer which consists of two identical ionization chambers which share a common electrode is described. The common electrode is mechanically connected to a membrane. In the absence of an external pressure, the currents in the two ionization chambers, induced by a radioactive isotope, cancel out each other. When an external pressure is applied on the membrane, the volumes of the 2 chambers will be changed. The resulting current is linearly proportional to the volume difference produced by the pressure and also to the ionization produced by the radioactive source. The theoretical considerations pertaining to the sensitivity and the linearity of the instrument are examined. Construction of the transducer is in progress. (TTT)

33500 ROLLING SHEET OR STRIP FROM PARTICULATE MATERIAL. Sturgeon, George McHardy; Sykes, George Michael Howard (to British Iron and Steel Research Association). British Patent 1,270,670. 12 Apr 1972. Filed 30 Oct 1968.

The rolling system described includes the use of γ-ray gauges for indicating the density of the rolled product. (UK)

33501 INSTRUMENTATION EFFECTS ON ERRORS IN NUCLEAR METHODS FOR SOIL WATER AND DENSITY DETERMINATION. Stone, J. F. (Oklahoma State Univ., Stillwater). Soil Sci. Soc. Amer., Proc.; 36: No. 2, 261-4(Mar-Apr 1972).

The commonly used ratio calibration of neutron scattering soil moisture meters tends to obscure errors due to random event counting, dead time, and drift phenomena not fully compensated for by the ratio. These effects are analyzed in the light of the demands of the very high count rates in many scintillation systems being currently reported. Dead time is always reduced by using high pulse-rate resolution equipment. Such is not always available for experimental work and the errors entailed are discussed. Equations describing the errors in ratio counting are discussed. The size of the standard material is a factor in some of the error terms. Some of the errors reduce to zero at the point where the count obtained in the soil is equal to the reading in the standard. Thus, it is desirable to construct the standard such that the ratio = 1 appears on the calibration curve (preferably above the center). (auth)

33502 SOURCE-DETECTOR GEOMETRY EFFECT ON NEUTRON PROBE CALIBRATION. McCauley, G. N.; Stone, J. F. (Oklahoma State Univ., Stillwater). Soil Sci. Soc. Amer., Proc.; 36: No. 2, 246-50(Mar-Apr 1972).

A laboratory experiment was conducted to develop a method for the nondestructive determination of the midpoint of the anode wire and the center of the sensitive volume of a boron trifluoride neutron detector tube. These points were found to coincide and would be expected to do so for all such detector tubes of symmetrical construction. The measurements on the detector tube were determined from X-ray radiographs by triangulation. This center point coincides with the midpoint of the portion of the detector between the bottom and seam near the top. Using the center of the sensitive volume as a reference point, the effect of position of the neutron source on the count rate in hydrogenous media was studied. Hydrogenous media used include urea, aluminum sulphate, water, and the paraffin shield for the probe (Nuclear-Chicago, model P-19). Materials were contained in 210-liter drums. Second degree curves fit the data of count rate vs. distance between source and reference point. The center of the sensitive volume coincided with the point of greatest count rate. The center was also the position for greatest sensitivity to water content. Results indicate that changes of source position as small as 0.5 cm from the position at original calibration will significantly change the calibration curve. Users can detect such changes by monitoring ratios of readings in two different hydrogenous media in the laboratory. Any such change in source-detector geometry will produce a change in ratio. Positional changes may be the result of either a source movement or replacement of detector tube with one of different dimensions. (auth)

33503 LABORATORY STUDY ON THE MEASUREMENT OF SOIL DENSITY BY GAMMA RAY BACKSCATTERING TECHNIQUES. **Uppal, H. L.; Gupta, S. K. (Central Road Research Inst., Delhi). Indian Geotech. J.; 1: No. 1, 37-52(Jan 1971).**

A method of measuring the soil density by backscattering of γ-rays is described. The object of the study was to determine the effect of physical variables such as soil texture and moisture content on the scattering of γ-rays and hence on the measurement of bulk density using γ-rays. An indigenously made nuclear device used for the study was assembled at the Central Road Research Institute, New Delhi. The principle on which it is based, its design considerations, safety measures adopted and fabrication of the probe, are described in detail. The type of electronic set-up used is also mentioned. Three types of soils and dry sand were studied. The wet density-count rate curve in the case of soils was irregular, because of the moisture present in them, whereas the dry density-count rate curve in the case of sand was found to be a straight line. So, in the later studies, only count-rate vs dry density was plotted, using Proctor's method. The sensitivity of the instrument depended on the soil texture and was better with clay soils than the sandy ones. The count-rate changed more markedly with change in moisture content, in the case of clay soils than in others and it was not the same at all levels of moisture content. Also, the change was minimum for a considerable range of moisture above the optimum moisture content (OMC). These studies have given rise to the development of a methodology, which consists in bringing the soil to a moisture content equivalent to the optimum or above it, but slightly below saturation, before determining the density, since this range does not affect the value of dry density as determined by the probe. It also shows that the present practice of calibrating count-rate against wet density is not accurate, because the count-rate-dry density relation is valid only in a restricted range of moisture content. (INIS)

33504 BUILDING-BRICK SYSTEM OF RADIONUCLIDE INSTRUMENTS FOR INDUSTRIAL MEASUREMENT AND CONTROL. **Kubalek, J. (Vyzkumny Ustav Pristroju Jaderne Techniky, Premysleni, Czech.). Radioisotopy; 13: No. 1, 31-54 (1972). (In Czech).**

A survey is given of individual parts of a kit of radionuclide instruments with ionization chambers designed principally for industrial measurement and control. A flow diagram of the mutual connections is presented and the general idea of the building-brick system is discussed. The application of the parts of the kit is exemplified by a floor covering thickness gage installed in a four-roll calendar. (auth)

33505 TOTAL POLLUTION SYSTEM MONITORING (TOPOSYM). Badgett, Charles O. (Industrial Nucleonics Corp., Columbus, Ohio). Isotop. Radiat. Technol.; 9: No. 3, 278-9(Spring 1972).

The properties of radiometric instruments suggest their use in a TOPOSYM arrangement, the concept of which provides for controlling industrial pollution in the plant itself, i.e., in the process where the pollutant occurs or is formed or at the point where it might be released to the environment. Radiometric instruments can be used to determine the pollutant in the raw material, at any stage of the processing, and in the effluent and can be coupled with control instruments to stop the process whenever limits are exceeded. (R.W.R.)

33506 RADIATION EMISSION AND DETECTION APPARATUS FOR DETERMINING DENSITY OF A MATERIAL. Campbell, Patrick J. U. S. Patent 3,655,977. 11 Apr 1972. Filed 2 Apr 1969.

Apparatus is described which is capable of determining characteristics of a volume of material by both measuring (a) the amount of radiation emitted by a radioactive source transmitted a predetermined distance through the material and by measuring (b) the amount of radiation from a source reflected by the material. The apparatus includes an exterior housing having contained therein at a predetermined location adjacent its bottom wall a radiation shielded container for a radioactive source. The container has a radiation transparent opening through which radiation from the radioactive source is emittable in a predetermined direction, and a shutter arrangement is provided for selectively blocking and freeing the opening. A radiation detector is contained within an end section of an elongated rod which may be secured to the housing at a first location, shielded from the source container opening, at which the detector will detect substantially only radiation which is reflected toward the detector, and at a second location at which the detector depends downwardly below the bottom wall of the housing in direct line-of-sight to the opening for the detection of radiation emitted from the opening and transmitted a predetermined distance through the material located between the opening and the detector. (auth)

33507 COMPENSATED NUCLEAR DENSOMETER AND METHOD. Zimmerman, Carl W. (to Halliburton Co.). U. S. Patent 3,657,532. 18 Apr 1972. Filed 11 Apr 1969.

A method and apparatus are described for compensating a digital nuclear densimeter for decay in the intensity of the radiation source, drift and instability of the detectors, temperature, and other factors. A common source of radiation is used to irradiate separate detectors through substances of known and unknown density and a ratio between the number of pulses in the output signals of the detectors taken to compensate for conditions common to both detectors. The detectors are energized by a common source to minimize drift and instability and a circuit is provided for digitally linearizing the relationship between the number of pulses in the output signal and the density of the substance under investigation. (auth)

Radiation Effects on Instrument Components, Instruments, and Electronic Systems

33508 (JPL-TM-33-491) PROCEEDINGS OF THE FOURTH ANNUAL CONFERENCE ON EFFECTS OF LITHIUM DOPING ON SILICON SOLAR CELLS, PASADENA, CALIF., APRIL 29, 1971. Berman, P. A. (ed.) (Jet Propulsion Lab., Pasadena, Calif.). 15 Sep 1971. 120p. (CONF-710450).

Separate abstracts were prepared for the 13 papers presented. (W.H.K.)

For abstracts of individual papers see: 33509—33521.

33509 (JPL-TM-33-491, pp 1-3) SOME MAJOR RESULTS OF THE FOURTH ANNUAL CONFERENCE ON EFFECTS OF LITHIUM DOPING ON SILICON SOLAR CELLS. Berman, P. A. (Jet Propulsion Lab., Pasadena, Calif.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Fabrication, properties, and radiation hardening methods for lithium-doped silicon solar cells, discussed at the conference, are summarized. (W.H.K.)

33510 (JPL-TM-33-491, pp 4-12) LITHIUM-DOPED SOLAR CELLS FOR SPACE USE. Payne, P.; Ralph, E. L. (Heliotek, Sylmar, Calif.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

The lithium-doped solar cell research and development carried out by the Heliotek Division of Textron, Inc. is summarized. Experimental work aimed at the improvement of cell processes and efficiencies and the fabrication and statistical analysis of various lithium-doped solar cell types are briefly described. (W.H.K.)

33511 (JPL-TM-33-491, pp 13-30) DEVELOPMENT AND FABRICATION OF LITHIUM-DOPED SOLAR CELLS. Iles, P. A. (Globe-Union, Inc., El Monte, Calif.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Topics include cell fabrication sequence, lithium application, lithium diffusion cycles, lithium distribution, JPL shipment C13, and more complex cell structures. (W.H.K.)

33512 (JPL-TM-33-491, pp 31-4) AIR FORCE/ION PHYSICS HARDENED LITHIUM DOPED SOLAR CELL DEVELOPMENT. Kirkpatrick, A.; Bartels, F.; Carnes, C.; Ho, J.; Smith, D. (Ion Physics Corp., Burlington, Mass.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells, Pasadena, Calif. (29 Apr 1971).

The status of the project by the Ion Physics Corporation to develop a lithium doped solar cell that is hardened against both space radiation and nuclear weapons burst environments is discussed. (W.H.K.)

33513 (JPL-TM-33-491, pp 35-9) DEPENDENCE OF DEFECT INTRODUCTION ON TEMPERATURE AND RESISTIVITY AND SOME LONG-TERM ANNEALING EFFECTS. Brucker, G. J. (Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Results of an investigation of lithium properties in bulk-silicon samples before and after irradiation to develop a model of the damage and recovery mechanisms in irradiated lithium-doped solar cells are discussed. Experiments on 1-MeV electron irradiated bulk samples included Hall coefficient and resistivity measurements taken as a function of (1) bombardment temperature, (2) resistivity, (3) fluence, (4) oxygen concentration, and (5) annealing time at temperatures from 300 to 373 K. (W.H.K.)

33514 (JPL-TM-33-491, pp 41-51) DENSITY AND FLUENCE DEPENDENCE OF LITHIUM CELL DAMAGE AND RECOVERY CHARACTERISTICS. Faith, T. J. Jr. (Radio Corp. of America, Princeton, N. J. Astro-Electronics Div.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells, Pasadena, Calif. (29 Apr 1971).

Experimental results on lithium-containing solar cells point toward the lithium donor density gradient dN_L/dw as being the crucial parameter in the prediction of cell behavior after irradiation by electrons. Recovery measurements on a large number (180) of oxygen-rich and oxygen-lean lithium cells fabricated by three manufacturers have confirmed that cell recovery speed is directly proportional to the value of the lithium gradient for electron fluences ranging from 3×10^{13} e/cm^2 to 3×10^{15} e/cm^2. An approximate relationship between the time to half recovery, θ, (at room temperature) the lithium gradient, dN_L/dw, and the 1-MeV electron fluence Φ was derived for oxygen-rich cells which holds for the entire range of fluences tested. Also, a relation for oxygen-lean cells is presented which holds up to 1×10^{15} e/cm^2, above which a more rapid increase with fluence occurs, probably due to the greater significance of lithium depletion during irradiation. Seventy oxygen-rich (C13) cells with initial performance significantly above a group of commercial 10 Ω-cm n/p cells were recently irradiated to fluences ranging from 3×10^{13} to 3×10^{15} e/cm^2. Through pre-irradiation capacitance measurements (giving dN_L/dw) and pre- and post-irradiation short-circuit current and diffusion length measurements, a relationship was derived between the diffusion length damage constant before recovery, $K_L(O)$, and dN_L/dw and Φ. Gradient measurements have also been correlated with lithium diffusion schedules. Results have shown that long diffusion times ($\gtrsim 5$ h) with a paint-on source result in large cell-to-cell variations in gradient, probably due to a loss of the lithium source with time. They also indicate that this problem can be overcome either by short diffusion times or by use of an evaporated lithium source. (auth)

33515 (JPL-TM-33-491, pp 53-64) DEGRADATION AND RECOVERY MECHANISMS IN LITHIUM-DOPED SOLAR CELLS. Downing, R. G.; Carter, J. R. Jr. (TRW Systems Group, Redondo Beach, Calif.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Lithium-doped solar cells were evaluated for radiation hardness. The lithium concentrations in the devices were determined, and the effects of 1- and 28-MeV electron irradiations at 3×10^{14} and 3×10^{15} e/cm^2 were studied. Capacitance measurements were used to systematically study the changes in lithium concentration which occur during irradiation and recovery. (W.H.K.)

33516 (JPL-TM-33-491, pp 65-70) RADIATION TOLERANCE OF ALUMINUM-DOPED SILICON. Curtis, O. L. Jr.; Srour, J. R. (Northrop Corporate Labs., Hawthorne, Calif.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Data are presented that indicate that heat-treated Czochralski-grown aluminum-doped silicon that undergoes an appreciable resistivity increase ($\gtrsim$ a factor of two) during heating at ~450°C is significantly more resistant to both neutron and gamma irradiation than boron-doped material (or aluminum-doped material that either has not been heat-treated or does not experience an appreciable resistivity change during such a treatment). Data interpretation is, however, quite difficult due to the occurrence of severe trapping effects in heat-treated material. Studies of radiation effects on aluminum-doped silicon solar cells are planned for the near future to resolve these uncertainties in the bulk material results. (auth)

33517 (JPL-TM-33-491, pp 71-80) EXPERIMENTAL AND COMPUTER STUDIES OF THE RADIATION EFFECTS IN SILICON SOLAR CELLS. Leadon, R. E.; Naber, J. A.; Passenheim, B. C. (Gulf Radiation Technology, San Diego, Calif.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Results of an investigation on lithium-diffused bulk silicon are discussed. Electron spin resonance and infrared absorption were used to study certain specific defects, and minority-carrier lifetime measurements were used to study radiation-induced recombination centers. Also, a computer code that can be used for predicting the performance of silicon solar cells in various environments is described. (W.H.K.)

33518 (JPL-TM-33-491, pp 81-4) HALL EFFECT STUDY OF ELECTRON IRRADIATED Si(Li). Stannard, J. (Naval Research Lab., Washington, D. C.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Measurement of the Hall coefficient as a function of temperature between 15 and 300 K allows the separate determination of donor and acceptor concentrations in silicon. The concentrations were monitored in samples which were irradiated at 240 K by 1-MeV electrons and then thermally annealed at 300 K. The behavior of room temperature carrier concentration as a function of annealing time, the change in donor concentration caused by annealing at room temperature, and the change in acceptor concentration caused by annealing at room temperature are presented graphically for Si(Li) and Si(P). (W.H.K.)

33519 (JPL-TM-33-491, pp 85-90) OBSERVATION OF STRUCTURAL DEFECTS IN NEUTRON-IRRADIATED LITHIUM-DOPED SILICON SOLAR CELLS. Sargent, G. A. (Kentucky Univ., Lexington. Dept. of Metallurgical Engineering and Materials Science). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Electron microscopy has been used as a technique to observe the distribution and morphology of lattice defects introduced into lithium-doped silicon solar cells by neutron irradiation. Upon etching the surface of the solar cells after irradiation, crater-like defects are observed that are thought to be associated with the space charge region around vacancy clusters. The crater defect density was found to increase with increasing irradiation dose and increasing lithium content; however, the defect size was found to decrease with increasing dose and lithium. Thermal annealing experiments showed that the crater defects were stable in the temperature range 300 to 1200°K in all of the lithium-doped samples. Some annealing of the crater defects was observed to occur in the undoped cells which were irradiated at the lowest doses. (auth)

33520 (JPL-TM-33-491, pp 91-8) RADIATION DAMAGE AND ANNEALING OF LITHIUM-DOPED SILICON SOLAR CELLS.

Statler, R. L. (Naval Research Lab., Washington, D. C.). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

Results of measurements of power loss and power recovery following irradiation and annealing of Si(Li) solar cells are presented and discussed. The cells were irradiated with 1.2-MeV gamma rays, 1-MeV electrons, and 4-MeV protons. (W.H.K.)

33521 (JPL-TM-33-491, pp 101-13) RADIATION DAMAGE ANNEALING KINETICS. Dresselhaus, M. S. (Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering). 15 Sep 1971.

From fourth annual conference on effects of lithium doping on silicon solar cells; Pasadena, Calif. (29 Apr 1971).

The method and equipment that will be used to study the recovery of electron-irradiated Si(Li) solar cells are described. Kinetics modeling requires the observation of (1) the defects formed during irradiation; (2) how these defects are annealed out in the recovery process; and (3) how these defects affect the diffusion length, minority carrier lifetime, carrier removal rate, etc. The defects are classified into various categories, and the experimental techniques for studying the defects are reviewed. The application of the Shockley–Read–Hall theory for determination of minority carrier lifetimes is discussed, and an apparatus for spectral response studies is described. (W.H.K.)

33522 (SC-M-720133) METHOD TO DETERMINE THE RELATIVE DAMAGE PRODUCED IN SEMICONDUCTORS BY DIFFERENT NEUTRON SOURCES. McKenzie, James M. (Sandia Labs., Albuquerque, N. Mex.). 6 Dec 1971. 48p. Dep. NTIS.

A specification is presented which provides a method to describe a neutron radiation environment for semiconductors. The neutron environment is described in terms of a fluence of 14-MeV neutrons. The specification establishes how to measure the fluence of the 14-MeV neutrons and discusses the way to relate the damage of the 14-MeV neutrons to the damage from neutrons in an unknown spectral distribution. (W.H.K.)

33523 RADIATION EFFECTS ON JUNCTION TRANSISTOR NOISE STUDIED BY A COMPUTERIZED NOISE MEASURING SYSTEM. Kerns, David V. Tallahassee, Fla.; Florida State Univ. (1971). 261p. University Microfilms Order No. 72-10,030.

Thesis.

Numerous silicon bipolar devices, both NPN and PNP, were irradiated using 3 MeV electrons at increasing levels of fluence. Electrical parameter and shot noise measurements were made after each successive irradiation of the devices. The emitter base junction of a transistor greatly influences the behavior of the device, and therefore, the radiation induced changes in this diode were studied in detail. Numerous electrical measurements, such as the d.c. characteristics and a.c. admittances, were made in order to support the diode noise theory. The equivalent noise resistance of the diode was measured at frequencies around 100 kHz and its dependence on electron radiation fluence found. The properly biased transistor was investigated and the effects of the radiation on the d.c. currents, the gain and the small signal parameters were carefully studied to support an analysis of the change in the noise properties. The noise figure of the devices was measured utilizing a new system which is controlled by a Hewlett–Packard 2116B digital computer. The defects or defect complexes introduced by the electron bombardment serve as carrier recombination centers, and after each successive irradiation, the proportion of generation-recombination current to diffusion current increases. The theoretical expression for the equivalent noise resistance of the diode agrees with the experimental results well for moderate bias voltages, when recombination effects are included. The excellent agreement obtained between the theoretical expression for the noise figure and the data indicates that the theory which was developed is adequate to describe the noise behavior of silicon junction transistors, even when the effect of generation-recombination becomes large. Further, the largest increase in the noise figure with increasing radiation, is at the higher source resistance values. (TSS) (Diss. Abstr. Int., B)

33524 REACTOR IRRADIATION OF CHALCOGENIDE THRESHOLD SWITCHES. Tiainen, O. J. A.; Suntola, T. (State Inst. for Technical Research, Otaniemi, Finland). Acta Polytech. Scand., Phys. Nucl. Ser.; No. 85, 1-16(1971).

Chalcogenide threshold switches of Te–As–Ge–Si type were irradiated in a reactor up to a fast neutron fluence of 2.4×10^{17} n/cm^2. The radiation resistance of the devices was studied by measuring the radiation-induced changes in the small-signal conductivity and high-field currents of the sample material. The activation energies of small-signal conductivity and high-field currents were found to decrease due to irradiation, and in some cases a high radiation-induced increase in the off-state conductance was observed. (Finland)

33525 EFFECT OF SOME FACTORS ON THE PHOTOCURRENT VALUE OF AN ELECTRODE IRRADIATED WITH SOFT X RAYS. Ivanov, S. A.; Kharadzha, F. N.; Chigak, F. F. Izv. Leningrad. Elektrotekhn. Inst.; No. 77, 88-91(1969). (In Russian).

The effect of temperature of the photoemitter on the x-ray photocurrent was investigated, and the roles of the hard and soft components of the x radiation in the photoeffect were studied. The photocurrent was practically independent of the emitter temperature. The hard component of x radiation (E > 3.5 to 4 keV) passed through a filter with insignificant attenuation, whereas the soft component was almost absorbed completely. At a potential of 10 kV with a target of W, the photocurrent in the case of filtered radiation had the same value as in the case with a potential of one kV and unfiltered radiation. Thus the principal quantity of emitted electrons results from the long-wave component of the radiation. (K.S.W.)

33526 RADIATION EFFECTS ON GALLIUM ARSENIDE PHOSPHIDE AND GALLIUM PHOSPHIDE SCHOTTKY BARRIER DIODES. Neamen, Donald Arthur. Albuquerque, N. Mex.; Univ. of New Mexico (1971). 242p. University Microfilms Order No. 72-13,796.

Thesis.

Gallium arsenide phosphide (GaAsP) and gallium phosphide (GaP) Schottky-barrier diodes were fabricated and the transient ionizing and stable fast-neutron radiation effects on these diodes were determined. Diodes were fabricated on four types of n-type semiconductor material: (1) $GaAs_{0.6}P_{0.4}$ with a doping of 4×10^{14} cm^{-3}, (2) $GaAs_{0.5}P_{0.5}$ with a doping of 2×10^{15} cm^{-3}, (3) $GaAs_{0.5}P_{0.5}$ with a doping of 10^{17} cm^{-3}, and (4) GaP with a doping of 8×10^{15} cm^{-3}. The medium-doped $GaAs_{0.5}P_{0.5}$ diodes exhibited good electrical characteristics with an n factor related to the slope of the ln I vs V curve of 1.1 and an average barrier height of 1.20 eV measured by the capacitance method. The response of a Schottky barrier diode to a piecewise linear ionizing radiation pulse was developed. The analytical solution includes the effect of a constant electric field in the bulk semiconductor region. Results are given for the case of a simple triangular pulse as well as a pulse with three linear segments. The experimental photocurrent response of the diodes to an ionizing x-ray pulse was measured. The photocurrent response of the medium-doped $GaAs_{0.5}P_{0.5}$ diodes to the x-ray pulse correlates very well with the theoretical response to a piecewise linear pulse which approximates the x-ray pulse. The minority carrier lifetime and diffusion length of the semiconductor were determined by comparing the experimental and theoretical photocurrent responses. The GaAsP and GaP Schottky-barrier diodes were exposed to fast-neutron radiation ranging from a fluence of 1.01×10^{13} neutrons cm^{-2} (E > 10 keV) to 8.86×10^{16} neutrons cm^{-2} (E > 10 keV). The carrier-removal rate for the medium-doped diodes irradiated at a fluence of 9.67×10^{14} neutrons cm^{-2} ranged between 5 and 6 cm^{-1}. The decrease in minority carrier lifetime after neutron irradiation was observed from the transient photocurrent response of the irradiated diodes. The change in carrier concentration and conductivity with neutron irradiation was measured on five $GaAs_{0.5}P_{0.5}$ Hall-effect devices. These results correlate well with the Schottky-barrier diode measurements and also indicate that the $GaAs_{0.5}P_{0.5}$ material tends to become intrinsic after irradiation at high neutron fluence levels. Isochronal annealing of a few irradiated GaAsP diodes showed approximately a 40% recovery in the carrier concentration over a wide temperature range starting at 225°C and continuing up to the maximum annealing temperature of 580°C. (Diss. Abstr. Int., B)

33527 RADIATION DAMAGE EFFECTS FROM 2 MeV PROTONS IN SILICON SURFACE BARRIER DETECTORS. Grube, R.; Fretwurst, E.; Lindstroem, G. (Univ., Hamburg). Nucl. Instrum. Methods; 101: No. 1, 97-105(1972).

From second symposium on semiconductor detectors for nuclear radiation; Munich, Germany (6 Sep 1971).

The influence of radiation damage in silicon surface barrier detectors by 2 MeV protons for radiation doses up to 6×10^{12} protons cm^{-2} on the characteristic diode properties and the detector response to protons and alpha particles have been studied. From investigations with protons, significant correlations between the diode characteristics and the charge collection efficiency as well as the energy resolution as a function of the radiation dose are found. Experimental results from investigations of the detector response to alpha particles as a function of detector reverse bias, temperature and shaping time constant as well as measurements of the detector capacity are reported and their relations with radiation induced trapping, detrapping, and recombination effects are discussed. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 33060, 33078, 33266, 33307, 33396, 33556, 33679, 35246, 35247, 35560, and 35562.

33528 (AECL–4134) AN I_0 SUBTRACTION UNIT FOR USE WITH PULSED OR DC LIGHT SOURCES IN KINETIC SPECTROPHOTOMETRY. Selkirk, E. B.; Seddon, W. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Feb 1972. 8p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

Pulsed xenon arc light sources are commonly used to increase the analyzing light intensity, I_0, for kinetic spectrophotometry in pulse radiolysis experiments. A circuit is described which automatically subtracts the I_0 level, and when used in conjunction with a dual beam oscilloscope (Tektronix 556), allows the pulsed light profile, I_0, and transient signal to be recorded simultaneously. The unit can also be used with DC light sources, photomultipliers, photodiodes and photo voltaic devices without modification. (auth)

33529 (EGG–1183-1491) CHARACTERIZATION OF PHOTOGRAPHIC FILM. Tech Report L-1009. Lorber, H. W. (EG and G, Inc., Las Vegas, Nev.). 14 Oct 1970. 32p. Dep. NTIS.

The characterization of photographic film in such a way that granularity can be taken into account is considered; since no mathematical model is of any real use unless its parameters can be measured, attention is devoted as well to the problem of measuring the parameters which quantify the model. In essence, the behavior of an exposed and processed AgX emulsion (where X is a halide) is modeled in a sequence of stages, each stage being characterized as a mathematical operator whose behavior is described in terms of a mathematical function. The model introduced with a view toward analyzing optically dense photographs has five stages. In addition to modified optical diffusion, sensitometry, and chemical diffusion, a fourth stage is assumed which converts a nongranular expected developed-silver pattern into a granular approximation to it. The optical properties are then accounted for in a fifth stage. (2 figures) (R.W.R.)

33530 (HEDL-TME–72-25) NUCLEAR REACTOR INSTRUMENTATION EMPLOYING MICROWAVE TECHNIQUES. Billeter, T. Roger (Hanford Engineering Development Lab., Richland, Wash.). Mar 1972. Contract AT(45-1)-2170. 47p. Dep. NTIS.

Methods are described for using microwave techniques as reliable instrumentation for the monitoring and control of various physical properties of operating nuclear reactors. General characteristics of microwaves are discussed and the theory of operation of sensors using microwave techniques is described. Specific prototype systems are described for monitoring temperatures, pressure, and impurity measurements, as well as a prototype system for monitoring several physical properties simultaneously. (auth)

33531 (INR–1331) DIGITAL CHARGE INTEGRATOR. Glowacki, Stanislaw (Institute of Nuclear Research, Warsaw (Poland)). 1971. 21p. (In Polish). Dep. NTIS (U. S. Sales Only).

The electronic circuits employed in the measurement of electric charge are described. The charge can be delivered to the input of the converter in the form of electric current varying in the range from 10^{-9}A to the 10^{-3}A, without need for switching. The integrator consists of two parts: a charge-to-pulse converter and a 10^7 counts sealer. If the amount of scaled pulses is equal to the previously adjusted value, the signaling circuits are started. The required number of counts can be chosen in the range from 1 to 9,999,999 pulses. (12 figures) (auth)

33532 (JINR–E13-6224) ISOBARS FROM THE SPALLATION REACTION FOR NUCLEAR SPECTROSCOPY. Arlt, R.; Bystrov, V. A.; Habenicht, W.; Herrmann, E.; Raiko, V. I.; Strusny, H.; Tyrroff, H. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 14p. Dep. NTIS (U. S. Sales Only).

A method is described for isolation of radioactive nuclei of the isobars of some elements with a first ionization potential less than 6.5 eV from a target irradiated by 660-MeV protons. For this purpose an electromagnetic mass separator and ion source with surface ionization were used. An estimation of the activities of the nuclei obtained on the collector of the mass separator is made, and methods for their identification are described. As an illustration, the experimental results for the production of Rb, Sr, and some rare earth nuclei are given. A new isotope, ^{77}Rb ($T_{½}$ = 3.9 min), was identified. (5 figures, 3 tables) (auth)

33533 (KFK-EXT–22/71-6) CONCEPT FOR DESIGN AND SPECIFICATION OF CAMAC MODULES. Heep, W.; Ottes, J.; Tradowsky, K. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Jul 1971. 13p. (In German). INIS.

General rules for designing CAMAC modules are proposed. All modules have a status and a control register. Alarm generation and handling are standardized. On all commands the module is able to execute, the Q signal is generated. These rules meeting the CAMAC specifications support the design engineer and would help to generate modules with a certain amount of common features valuable in the software field. (INIS)

33534 (RD/B/N–2090) COMPUTER SYSTEM FOR THE ON-LINE PROCESSING OF DATA FROM THE BNL γ-CELL RIGS. Russell, R. D. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1971. 21p. Dep. NTIS (U.S. Sales Only).

A guide is presented to the data processing system developed for the γ-cell at Berkeley Nuclear Laboratories. The component parts are described and their interrelation, to each other and to the γ-cell rigs, is shown. An indication is given of the sources of further information necessary for fault finding or for any future modifications which might be desirable. (auth) (UK)

33535 (RDT-F–3-11-T(2-72)) MASS SPECTROMETER HELIUM LEAK DETECTION FOR INSTRUMENTS AND SMALL COMPONENTS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Feb 1972. 12p. RSO.

The requirements are prescribed for detecting and locating leaks and measuring the leak rate in instruments and other small components using a helium mass spectrometer leak detector. Six procedures are described, and records and documentation requirements are identified. (W.H.K.)

33536 (UCRL–73795) NEVADA AUTOMATED DIAGNOSTIC SYSTEM. McCall, John R. (California Univ., Livermore. Lawrence Livermore Lab.). 8 Mar 1972. 11p. (CONF-720312–4). Dep. NTIS.

From Underground nuclear test measurement symposium II; Menlo Park, Ca. (21 Mar 1972).

The system design criteria, progress to date, and planned future development of the Nevada Automated Diagnostic System are presented. NADS is a centralized, digital, data acquisition, transmission, and analysis system being developed by LLL and EG&G. It is designed to expedite the diagnosis of underground nuclear tests and their effects. The system described consists of a time-shared central controller and processor, a Digital Equipment Corporation PDP-10, with numerous standard peripherals and specialized interfaces. Data from Forward Area experiments are assembled in a forward communication facility — NADVAN — transmitted to a Control Point facility — NADCEN — and recorded or processed in real time. The data thus acquired are available for experimenters to process, as appropriate, in an interactive, time-shared manner. The controller also provides for control and monitoring of data-gathering equipment. Standard units, which have been developed to acquire test data in a digital form are described. Criteria are presented which will allow experimenters not directly associated with NADS to interface nonstandard units. The manner in which NADS provides a general utility to link an experimenter and his data-gathering equipment is detailed. (2 figures) (auth)

33537 PERFORMANCE OF A SMALL, PERMANENT-MAGNET, SINGLE-ELECTRODE PAIR, E x B VELOCITY FILTER AS A MASS SEPARATOR. Wilson, R. G. (Hughes Research Labs., Malibu, Calif.). Nucl. Instrum. Methods; 100: No. 1, 9–12(1972).

The performance of a 6″, permanent-magnet, single-electrode pair, E × B velocity filter as a mass separator in a 10 to 125 keV production ion implantation system is described. The design of this separator produces a nearly round beam spot (≈ 8mm for ≈ 20 μA of boron) and is capable of good separation of boron from the other components of BCl_3 or phosphorus from the other components of PF_5 at 40 cm from the exit. The separator requires only one simple power supply, and is of simple, reliable and economical design. Mass spectra are shown for beam energies of 60 and 10 keV; $^{11}B^+$ and $^{10}B^+$ are resolved at energies above about 40 keV. The resolving power of this mass separator is 15. (auth)

33538 BURN-OUT DETECTORS BY DIFFERENTIAL CIRCUIT METHOD. Kitayama, Yoshifumi; Namba, Shyunji; Kuniyasu, Yoshihito (Hiroshima Inst. of Tech.). Nippon Genshiryoku Gakkaishi; 14: No. 4, 159-63(Apr 1972). (In Japanese).

Burn-out detectors play an important role in increasing the experimental efficiency of burn-out experiments. For this reason, many studies have been reported on the bridge-type burn-out detector, but this form of detector is difficult to design and adjust. A burn-out detector that utilizes the differential circuit is described, and a discussion is given of the theory of detection and experimental results. (auth)

33539 ROLE OF INTERNAL CONVERSION ELECTRONS IN GADOLINIUM-EXPOSURE NEUTRON IMAGING. Harms, A. A.; Norman, G. R. (McMaster Univ., Hamilton, Ont.). J. Appl. Phys.; 43: No. 7, 3209-12(Jul 1972).

A radiation conversion and radiation transport model applicable to gadolinium-exposure neutron imaging is formulated. The resultant linear optical density representation is found to be in good agreement with experiment. The distinct conversion-electron contributions thus identified confirm the supposition about the dominant mode of image formation in gadolinium-exposure neutron imaging. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstract 33134.

33540 (KY–638) DISPOSAL OF FLUORINE AT LOW CONCENTRATIONS. Pulley, H.; Harris, R. L. (Paducah Gaseous Diffusion Plant, Ky.). 15 Apr 1972. Contract W-7405-eng-26. 10p. Dep. NTIS.

Experimental work was conducted to verify the safety of fluorine disposal by means of reaction with carbon and to investigate the efficiency of the process at low fluorine concentrations. It was found that the explosive reaction occasionally observed by other workers could be eliminated by the use of low surface area amorphous charcoal. Fluorine concentrations from 0.1 to 10% could be readily reduced to <50 ppM by reaction with heated charcoal to produce primarily gaseous nontoxic fluorocarbons. The process appears to provide a safe, efficient, and economical method for the disposal of waste fluorine. (auth)

33541 (LIB/Trans–408) DEPENDENCE OF THE SEPARATION COSTS OF A SEPARATION NOZZLE FOR ^{235}U ENRICHMENT ON LOAD CONDITION. Schubert, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). Translated by I. A. Mumme for Australian Atomic Energy Commission, from report KFK–1439. 21p. Dep. NTIS (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 26: 15370.

33542 (MLM–1920(TR)) OVER THE ENRICHMENT OF THE STABLE ISOTOPE ^{34}S IN THE SYSTEM HYDROGEN SULFITE/SULFUR DIOXIDE. PART TWO: THE SYSTEM NH_4HSO_3/SO_2. Stiel, G.; Mueehle, K. Translated for Mound Lab., Miamisburg, Ohio, from Isotopenpraxis; 5: 429-32(1969). 12p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 25218. (auth)

33543 (MLM–1921(TR)) OVER THE ENRICHMENT OF THE STABLE ISOTOPE ^{34}S IN THE SYSTEM HYDROGEN SULFITE/SULFUR DIOXIDE. PART THREE: THE EFFECT OF COLUMN PACKING ON EFFICIENCY OF SEPARATION. Stiel, G.; Winkler, R.; Mueehle, K. Translated for Mound Lab., Miamisburg, Ohio, from Isotopenpraxis; 5: 437-8(1969). 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 25221. (auth)

33544 GOVERNMENT ACT PERTAINING TO THE AGREEMENT OF MARCH 4, 1970, BETWEEN THE FEDERAL REPUBLIC OF GERMANY, THE KINGDOM OF THE NETHERLANDS, AND THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND, CONCERNING THE COOPERATION IN THE DEVELOPMENT AND APPLICATION OF THE GAS CENTRIFUGE PROCESS FOR THE PRODUCTION OF ENRICHED URANIUM, JULY 15, 1971. Bundesgesundheitsblatt; 2: No. 33, 929-52(1971). (In German).

The German Bundestag passed the following act: Article 1: The agreement ratified and signed on March 4, 1970 in Almelo by the Federal Republic of Germany, the Kingdom of the Netherlands, and the United Kingdom of Great Britain and Northern Ireland for the purpose of a cooperation in the development and use of the gas centrifuge process for the production of enriched uranium is thus given the approval of the Bundestag. The full text of the agreement is published further below. Article 2: (1) This act will become effective on the day following the day of its proclamation. (2) The day on which the agreement becomes effective as in accordance with Art. XII, sentence 1 of the agreement is to be announced in the Bundesgesetzblatt. (INIS)

33545 CONCEPTUAL DESIGN OF A UF_6 CIRCULATING LOOP. Muramatsu, Takio (First Atomic Power Industry Group, Tokyo). FAPIG (Tokyo): No. 62, 100-4(Aug 1971). (In Japanese).

An outline on conceptual design of a UF_6 circulating loop simulating a gas diffusion stage for JAERI is given aimed at solving technical problems, collecting operating information, and improving components which are necessary for development of uranium enrichment technology. Functions of the loop, design condition of an axial flow compressor, a diffusion tower, a cold trap are explained. Design principle and problems of each major component are also discussed. Further, operation and control system of future cascade is envisaged. (Japan)

33546 INFLUENCE OF GEOMETRIC PARAMETERS ON THE PERFORMANCE OF SEPARATING NOZZLE ELEMENTS. Bier, W.; Weis, F. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.). Kerntechnik; 14: No. 3, 105-13 (Mar 1972). (In German and English).

The separating nozzle process for enrichment of ^{235}U is based on the mass-dependent centrifugal force generated in a curved jet of a He$-UF_6$ mixture. The separating nozzle, elements used in this process have critical slit dimensions of about 0.01 to 0.02 mm. The costs of mass-fabrication of the nozzle elements will strongly depend on the required accuracy of the critical slit dimensions. The effect of variations in the most important dimensions on the separative power of the nozzle elements was investigated. As a result, rules are given to obtain the economic optimum for fabrication tolerances. (auth)

33547 CHEMICAL TREATMENT OF MAGNESIUM AND CADMIUM ISOTOPES SEPARATED THE ELECTROMAGNETIC WAY. Kellner, K. (Zentralinstitut fuer Isotopen- und Strahlentechnik, Leipzig). Isotopenpraxis; 8: No. 2, 61-4(Feb 1972). (In German).

Isotopes separated in an electromagnetic separator are contaminated with many foreign elements. In order to prepare isotope-enriched material for scientific research work, it is necessary to separate the accompanying elements and to transfer the isotope into a stable final state. The technology of chemical treatment of magnesium and cadmium isotopes separated electromagnetically is described. Furthermore, chemical treatment of samples for mass-spectrometric isotope analysis of both elements is mentioned. (auth)

33548 CLOSED SYSTEM GENERATION AND CONTAINERIZATION OF RADIOISOTOPES FOR ELUTING A DAUGHTER RADIOISOTOPE FROM A PARENT RADIOISOTOPE. Montgomery, James R.; Struttman, Lloyd G. (to Mallinckrodt Chemical Works). U. S. Patent 3,655,981. 11 Apr 1972. Filed 29 Nov 1968.

Apparatus is described for eluting a sterile daughter radioisotope from a parent radioisotope and containerizing the resultant eluate in an evacuated container having a rubber stopper, providing for delivery of a sterile pyrogen-free eluant from a sealed supply through a sterile charge of the parent radioisotope sealed in a shielded generator and thence to a tubular needle adapted to be pierced through the stopper of the evacuated container for suctioning the eluant from the sealed eluant supply into the generator and for suctioning the resultant eluate into the container. The needle is applied to a fitting on a plunger adapted to be pushed down to pierce the needle through the stopper. Eluate is delivered from the generator to the fitting for flow through the needle via an eluate conduit having a flexible tubing portion permitting movement of the plunger and the fitting, with an arrangement whereby the plunger, when retracted, pinches the flexible tubing portion closed, the flexible tubing portion being automatically released when the plunger is driven downward to open the flexible tubing portion for flow therethrough of the eluate under suction induced by the piercing of the needle through the stopper into the evacuated container. (Official Gazette)

Isotopic Power Sources

33549 (HIT–4086-2) DEVELOPMENT OF A RADIOISOTOPE HEAT SOURCE SUBSYSTEM FOR HEART DEVICES. Final Report. (Hittman Associates, Inc., Columbia, Md.). Nov 1970. Contract AT(30-1)-4086. 181p. Dep. NTIS.

The results of a program to design, fabricate, and test radioisotope heat source subsystems consistent with miniature Stirling and Rankine converter technology are summarized. Potentially, such heat source/converter systems with appropriate control systems could supply mechanical energy to a heart pump which could augment or replace the human heart. The heat source subsystem designed was based on a 30W ^{238}Pu fuel inventory. The fuel capsule was doubly incapsulated with the PuO_2 in electrorefined oxide form. To minimize the fuel inventory requirement, 48 Watt hours of thermal energy storage capability were included to meet occasional body demands requiring greater than 30 Watts of thermal energy. Three heat source subsystems were fabricated. One was designed in accordance with Stirling converter requirements, and was incorporated in a bench model for test evaluation. Another was designed for a Rankine converter and was similarly incorporated in a bench model for test evaluation. The bench models utilized both electrical and ^{238}Pu radioisotope energy supplies. The third heat source subsystem was delivered to Pacific Northwest Laboratory for in-phantom dosimetry testing. Bench model testing of both the Stirling and Rankine subsystems indicated relatively high thermal efficiencies. The Stirling heat source thermal efficiency is estimated at 92% and the Rankine efficiency at 85%. Heat withdrawal characteristics were found to be independent of heat source orientation for both systems. For the stirling system, receiver temperature was somewhat dependent on heat withdrawal rate and thermal energy storage initial condition. Measured Rankine boiler temperatures were lower than design values due to inadequate heat transfer in the steam phase. Outlet temperature increased with heat delivery rate due to improvement in heat transfer characteristics as the steam flow rate increased. (auth)

33550 (ORNL-TM-3608) CHEMICAL VAPOR DEPOSITED REFRACTORY METAL CAPSULES FOR RADIOISOTOPE SOURCES. Federer, J. I.; Haff, K. W.; Martin, W. R.; Ramey, D. W. (Oak Ridge National Lab., Tenn.). Dec 1971. Contract W-7405-eng-26. 9p. (CONF-720410-2). Dep. NTIS.

From third international conference on chemical vapor deposition; Salt Lake City, Ut. (24 Apr 1972).

Tungsten capsules have been deposited by hydrogen reduction of WF_6 and creep tested to demonstrate their utility as containers for isotope heat sources. The capsules were subjected to stepwise pressure increases at 1650°C (simulating helium generation of some isotopes) until failure occurred. The tangential stress at rupture was about 3300 psi and rupture occurred after a circumferential strain of 19%. These results showed that the rupture life can be predicted on the basis of the stress-temperature history. The chemical vapor deposition (CVD) technique used to produce this pressure vessel appears to be sound, and the internal pressure test shows the deposits to be strong and ductile at the elevated temperatures. (auth)

33551 U. S. NAVY RADIOISOTOPIC POWER GENERATOR PROGRAM. Cope, R. P.; Fleming, T. P. (Naval Facilities Engineering Command, Washington, D. C.). Isotop. Radiat. Technol.; 9: No. 3, 323-9(Spring 1972).

The Navy Radioisotopic Power Generator (RPG) Program is managed and administered by the Naval Facilities Engineering Command (NAVFAC) and its field office, the Naval Nuclear Power Unit. The RPGs convert heat directly to electricity, operating on the thermocouple principle, and are used in inaccessible areas where long-life unattended power sources are required. Current prices of RPGs range from $45.5 thousand for an 8-W unit to $63.7 thousand for a 25-W unit. Units that produce up to 2 kW are expected to be available by 1976, and near-future Navy efforts are expected to be concentrated in the higher power units. (auth)

33552 STATUS OF U. S. RADIOISOTOPIC SPACE POWER SYSTEMS. Carpenter, R. T. (AEC-NASA Space Nuclear Systems Office, Washington, D. C.). Isotop. Radiat. Technol.; 9: No. 3, 330-44(Spring 1972).

Radioisotopic thermoelectric generators developed by U. S. government agencies to power automatic instrumentation in space studies are discussed. (auth)

Radiation Sources

33553 POWERFUL ^{244}Cm + Be SOURCE OF NEUTRONS. Tyufyakov, N. D.; Shtan, A. S.; Trykov, L. A.; (and others). At. Energ. (USSR); 32: No. 3, 237-8(Mar 1972). (In Russian).

An experimental ^{244}Cm-Be source was prepared which yielded (4π geometry) 1.8×10^9 n/sec. A mixture of Cm oxide and powdered Be metal was sealed in a double ampul of stainless steel with an outer diameter of 35 mm and a height of 60 mm. The energy spectrum of the unit from 0 to 12 MeV is shown graphically, the average value being 3.6 MeV. A comparison with other neutron sources is described. (K.S.W.)

33554 ISOTOPES AND RADIATION TECHNOLOGY. VOLUME 9, NUMBER 3. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Greene, R. E.; McKinney, F. E.; Raaen, Helen P. (eds.). One of Four Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Oak Ridge, Tenn.; Oak Ridge National Laboratory (Spring 1972). 127p. GPO
$0.70.

Twenty-two papers and numerous short summaries and reviews of publications related to recent developments in isotopes and radiation technology are presented. A separate abstract was prepared for each of seven papers. Abstracts of the remaining 15 papers were previously published in NSA. (L.C.L.)

For abstracts of individual papers see: 33055, 33475, 33505, 33551, 33552, 33555, and 33981.

33555 FINNISH APPLICATIONS OF RADIOISOTOPES. Kuusi, J. (Reactor Lab., Otaniemi, Finland). Isotop. Radiat. Technol.; 9: No. 3, 359-60(Spring 1972).

The activities of the Applied Radiation and Isotopes Division of the Reactor Laboratory at Otaniemi, Finland are summarized. The use of radioisotopes in radioisotopic methods of analysis for industrial quality and process control, including waste-water analysis and management, in tracer studies of industrial processes, and as neutron sources for neutron activation analysis applications in environmental studies, geology, medicine, and industry are briefly described. (L.C.L.)

Design and Fabrication

33556 PORTABLE X-RAY SOURCES. Tsukerman, V. A. Vestn. Akad. Nauk SSSR; No. 11, 18-25(Nov 1971). (In Russian).

Among the recent developments which have reduced the size and weight of x-ray equipment are the use of short-duration nanosecond high-voltage pulses applied across a vacuum gap in a tube and the replacement of the incandescent cathode by an auto-electron emitter. Commercial equipment is discussed to illustrate certain principles. Isotopes now available which can provide x and γ radiation are, in addition to the well-known ^{60}Co and ^{137}Cs, ^{55}Fe, ^{238}Pu, and ^{241}Am. These isotopes have led to the development of microradiography, the principles and some applications of which are discussed. (K.S.W.)

33557 NON-SHIFTING RADIATION SOURCE CAPSULE. Dukes, John R. (to Industrial Nucleonics Corp.). U. S. Patent 3,655,984. 11 Apr 1972. Filed 18 Dec 1969.

A substantially immobile "non-shifting" relatively low-energy radiation source including a particulate radioisotope-bearing material positioned within a chamber formed in a capsule is described. Movement of the radioactive isotope element or any attenuating mass is prevented by a porous deformable conformational barrier member which has pores therein smaller than the smallest particle adjacent to the barrier and which prevents any attenuating producing movement of any particulate material within the capsule. In the case of gas-producing radioisotopes, provision is made to permit escape of gas while preventing movement of attenuating masses or radioactive isotope material. Various radioisotopes and barrier members are described as well as various ways to assemble a "non-shifting" source. (Official Gazette)

Industrial Uses

Refer also to abstracts 33575, 33576, and 35667.

33558 (CNAEM-57) APPLICATION OF FOOD IRRADIATION IN THE WORLD. Derman, Ayten (Cekmece Nuclear Research Center, Istanbul (Turkey)). Jul 1968. 30p. (In Turkish). Dep. NTIS (U. S. Sales Only).

The application of irradiation for preserving various kinds of food in different countries is reviewed. The sources and types of ionizing radiations, their application in food preservation, and the legislation, regulations, and legal problems in food irradiation are discussed. (56 references) (Key Turk. Sci., Elec. Eng. Electron.)

33559 (INR-1372) RADIOISOTOPE METHOD FOR MIXING INVESTIGATIONS OF GRANULAR SUBSTANCES. Swigon, Krystyna; Michalik, Jerzy; Radwan, Maciej (Institute of Nuclear Research, Warsaw (Poland)). 1972. 24p. (In Polish). Dep. NTIS (U. S. Sales Only).

The tracer method for investigations of industrial-scale mixing of granular substances is discussed. A continuous method for labeling of great masses of granular substances in iron ore sintering plants is described. Interpretation of data and methods for evaluation of mixing efficiency for unit vessels as well as for all technological processes are discussed. (auth)

33560 (RT/BIO-(70)55) PROBLEMS RELATED TO COMMERCIAL FOOD IRRADIATION. Baraldi, D. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1971. 3p. (In Italian). INIS.

Food irradiation is today commercialized in several countries. Experiments of irradiation techniques, wholesomeness studies and animal feed test were carried out extensively in the last few years reaching results which are now defined. Other aspects of the food irradiation techniques which represent important factors in applying this method more extensively are discussed and include: packaging materials, radiation source, consumer's acceptance of irradiated food, and irradiation cost. (INIS)

33561 STUDIES ON THE WHOLESOMENESS OF THE GAMMA-IRRADIATED RICE. I. ON THE FOOD COMSUMP-

TION, WEIGHT GAIN, FOOD EFFICIENCY, AND GROWTH RATE OF MICE. Park, Chang Kyu; Kim, Sung Kih; Kim, Hong Lyur; Kim, Hyong Soo. Han'guk Sikp'um Kwahakhoe Chi; 3: No. 2, 110-16(1971). (In Korean).

In order to examine the wholesomeness of gamma-irradiated polished rice, 400 albino rats were fed on four different diets consisting of rice irradiated at 50 Krad (LLTG) and 100 Krad dosages (HLTG), nonirradiated rice (PCG), and wheat (NCG) for a 7 month period. No significant difference was observed among the four diets with respect to feed intake, gain of body weight, feed efficiency, and growth rate of the experimental animal. (Korean Sci. Abstr.)

33562 PROCEEDINGS OF THE SOS/70 THIRD INTERNATIONAL CONGRESS ON FOOD SCIENCE AND TECHNOLOGY. Conference Held in Washington, D. C., August 9–14, 1970. Chicago; Institute of Food Technologists (1971). 964p. $15.00. (CONF-700856).

One-hundred-twenty-one articles are included; separate abstracts were prepared for two. The remaining 119 articles contain information on: education for food science and technology; information and documentation; food acceptance in a changing world; nutritional considerations in the application of food technology; new sources of proteins; food fat and human health; biological evaluation of the nutritive value of foods; sensory properties of foods; food engineering; food preservation and protection; physical and chemical properties of foods; food safety; food laws and regulations; and water supply and water disposal. (P.C.H.)

For abstracts of individual papers see: 33563 and 33564.

33563 FOOD IRRADIATION: PROGRESS, PROBLEMS, AND PROSPECTS. Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay). pp 595-603 of Proceedings of the SOS/70 Third International Congress on Food Science and Technology. Chicago; Inst. of Food Technologists (1971).

From third international congress on food science and technology; Washington, D. C. (9 Aug 1970). See CONF-700856.

The topics discussed include: radiation processing; high- and low-dose processes; combination treatments; deterrents to commercialization; criteria for wholesomeness; microbiology of irradiated foods; evaluation for toxicity; problems of toxicity testing; set-backs to progress; international status; balanced view; economics; wholesomeness evaluation; international center for wholesomeness testing; and common approach to legislation. (P.C.H.)

33564 SAFETY OF IRRADIATED FOOD-BIOLOGICAL ASPECTS. Ley, F. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 806-15 of Proceedings of the SOS/70 Third International Congress on Food Science and Technology. Chicago; Inst. of Food Technologists (1971).

From third international congress on food science and technology; Washington, D. C. (9 Aug 1970). See CONF-700856.

Ionizing radiations in the form of γ rays from the radioisotopes ^{60}Co or ^{137}Cs, or electrons from electrical machines, have been proposed for the treatment of food for preservation or other purposes. Legislation controlling such use, introduced in many countries, requires that scientific evidence of the safety of each specific process be submitted to health authorities for appraisal. The nature of the data required is reviewed, with emphasis on the toxicological aspects and in particular on the problems in animal feeding experimentation. A few irradiated foods, in particular potatoes and wheat, have been cleared for human consumption in several countries and at an international level. (auth)

33565 STUDY ON GEOMETRICAL STABILITY OF A MULTI-ANVIL HIGH PRESSURE DEVICE BY GAMMA RAYS. Nagatomo, Tsuneto; Mazaki, Hiromasa; Shimizu, Sakae (Kyoto Univ.). Bull. Inst. Chem. Res., Kyoto Univ.; 50: No. 1, 1-7(Jan 1972).

The geometric stability or deformation of a multi-anvil (eight-anvil) high-pressure apparatus was investigated by the use of the γ-ray emitter (^{99m}Tc) embedded at the center of the device. Minute changes in the geometry of the apparatus continued throughout the period of operation. Modifications of the apparatus to improve the stability as well as the detection efficiency for γ rays from the embedded source are described. (auth)

33566 MEASURING WATER DRAINAGE RATE FROM WET STOCK FOURDRINIER SCREEN USING RADIATION SOURCE AND DETECTORS. Bossen, David A. (to Industrial Nucleonics Corp.). U. S. Patent 3,655,980. 11 Apr 1972. Filed 20 Jun 1968.

In a Fourdrinier papermaking machine, the variation in the mass of the slurry along the length of the Fourdrinier traveling forming screen and the rate of water drainage therethrough are determined by a radioactive wire threaded along the length of the screen, or a plurality of radioactive sources successively disposed therealong, in conjunction with either a single radiation detector moved synchronously with the screen or a plurality of detectors monitored continuously or scanned synchronously with the screen movement. (Official Gazette)

LIFE SCIENCES

Radiation Effects on Biochemicals (External Source)

Refer also to abstracts 33649, 33669, and 33703.

33567 (AEC-tr–7303, pp 1-8) CHANGE IN THE INTERACTION AMONG COMPONENTS OF DEOXYRIBONUCLEOPROTEINS UNDER THE INFLUENCE OF RELATIVELY LOW DOSES OF X RADIATION. Kulikova, L. G.; Spitkovskii, D. M.; Tseytlin, P. I. (Inst. of Medical Genetics, Moscow). Translated from Radiobiologiya; 11: No. 3, 323-8(May-Jun 1971).

A method of analysis of the effects of relatively low doses of ionizing radiation on solutions of deoxyribonucleoprotein (DNP), associated with the deproteinization of DNP in solutions with low ionic strength, is suggested. It is shown that the irradiation of DNP solutions (μ 0.7 mM) at doses of 100 rad and above leads to increasing lability of the DNA-protein bonds in the DNP complex. (tr-auth)

33568 (AEC-tr–7303, pp 9-17) MECHANISM OF THE RADIATION DAMAGE TO THE DEOXYRIBONUCLEOPROTEIN IN ANIMAL CELL CHROMATIN. Strazhevskaya, N. B.; Troyanovskaya, M. L.; Krivtsov, G. G. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 3, 329-34(May-Jun 1971).

The mechanism of damage to the DNA-protein complex in the γ irradiation of chromatin deoxyribonucleoprotein in calf thymus nuclei was investigated. It was established that damages in the structure of DNA are responsible for the formation of a strengthened nonspecific bond between DNA and protein, which is stable to phenol deproteinization. Amino acid analysis indicated that the strengthened nonspecific bond is formed between DNA and the acid proteins of the chromatin. This bond is neither electrostatic nor covalent, but is apparently effected through hydrophobic interaction. (tr-auth)

33569 (AEC-tr–7303, pp 18-23) STUDY OF DEGRADATION PRODUCTS OF DNP ARISING IN THE RAT THYMUS GLAND UNDER THE ACTION OF γ IRRADIATION, HYDROCORTISONE, AND DEGRANOL, BY THE METHODS OF SEPARATION ON PHOSPHATE-CELLULOSE AND VISCOSIMETRY. Vodolazskaya, N. A.; Ermolaeva, N. V. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 3, 335-8(May-Jun 1971).

The decomposition products of deoxyribonucleoprotein (DNP) contained in salt extracts obtained from the rat thymus gland 6 hrs after whole-body γ irradiation of rats at a dose of 600 R and intraperitoneal injection of hydrocortisone or degranol at a dose of 10 mg/100 g of weight were fractionated on phosphate-cellulose. An analogy was detected in the nature of the distribution of DNA and total protein of the extracts among three fractions: nonsorbed, weakly sorbed, and firmly sorbed. The size of the DNA fragments among the degradation products of DNP formed under the three influences compared was within the same range of values, from 2 to 3.8 million for large fragments and from 1.3 to 1.7 for the small ones. On the basis of the results obtained, it is suggested that the decomposition of DNP in thymocytes proceeds according to similar mechanisms in all the cases studied and is an expression of the initial stages of nonspecific autolysis of irreversibly damaged cells. (tr-auth)

33570 (AEC-tr–7303, pp 24-32) ELECTROPHORETIC INVESTIGATION OF ESTERASES OF THE RAT LIVER AND BLOOD SERUM AFTER LOCAL IRRADIATION OF THE LIVER. Bochkova, D. N.; Kashkin, K. P.; Surinov, B. P. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 3, 339-44(May-Jun 1971).

Local irradiation of the rat liver produces phase changes in the activity of 12 isoforms of esterases detected in liver extracts by electrophoresis in agar gel, including acetyl- and carboxylesterases. The activity of the acetylesterase fractions, especially those possessing the highest and lowest relative electrophoretic mobility, is subject to the greatest changes after irradiation. In addition, the ratio of the activity of the isoforms of the esterases in the hyaloplasm and of the cytoplasmic granules of the liver cells is disrupted. Seven days after irradiation, esterase fractions that were absent in the intact animals are detected in the blood serum. By 46 days, despite certain signs of normalization of the investigated indices, supplementary fractions again appear in the blood serum, and the activity of the basic isoforms of the esterases is increased. (tr-auth)

33571 (RLO–2225-T-15-9) PHOTOBIOLOGY AND PHOTOCHEMISTRY OF RIBONUCLEIC ACIDS. Progress Report, January 1971–March 1972. Gordon, Milton P. (Washington Univ., Seattle). Contract AT(45-1)-2225. 7p. Dep. NTIS.

Progress is reported in the following areas of research: the role of dimers in photoreactivation and the action of sunlight on RNA; decrease of the photoreactivated sector of TMV-RNA by intense uv radiation of the host plant; environmental effects on the photoreactivation ability of plants; photorepair of uv-irradiated tRNA; a general procedure for labeling DNA and RNA with tritium; and studies on the uptake of chloroplasts by HeLa cells in culture. (H.L.W.)

33572 IN VIVO METHYLATION OF BACTERIAL DNA FOLLOWING EXPOSURE TO ULTRAVIOLET LIGHT AND X RAYS. Whitfield, Bradford Lee. Gainesville, Fla.; Univ. of Florida (1971). 52p. University Microfilms Order No. 72-13,002. Thesis.

Escherichia coli 15T$^-$ (555-7) was irradiated with ultraviolet light (UV) and X-rays and the DNA examined for quantitative and qualitative changes in the methylation pattern. DNA synthesized following UV irradiation was under-methylated by approximately 25 percent as compared to DNA from unirradiated cells. The ratio of 6-methyladenine (6-MA) to 5-methylcytosine (5-MC) was unchanged. DNA synthesized following X-irradiation was methylated about 15 percent more than normal with a slight increase in the 6-MA to 5-MC ratio. No additional methylation or turnover of methyl groups could be detected in parental DNA present at the time of UV or X-irradiation. E. coli 15T$^-$ (555-7) synthesized "unmethylated" DNA by growth in the absence of methionine. UV irradiation of cells containing "unmethylated" DNA did not quantitatively change the cells' ability to subsequently methylate this DNA when methionine was added to the culture. The ratio of 6-MA to 5-MC in both control and UV irradiated cells changed from 1.8 ± 0.2 when examined 15 minutes after addition of methionine to 1.4 ± 0.1, the normal value, when examined 1 hour after methionine was added. (Diss. Abstr.)

33573 STUDY OF THE EFFECTS OF ULTRAVIOLET LIGHT IRRADIATION ON THE ELECTRON TRANSPORT SYSTEM OF ESCHERICHIA COLI. Scott, William E. Coral Gables, Fla.; Univ. of Miami (1971). 126p. University Microfilms Order No. 72-12,890. Thesis.

The ultraviolet sensitivity of the electron transport system of Escherichia coli at 2600 A was examined. The respiratory activity of crude cell preparations was found to be partially inactivated upon ultraviolet irradiation. Upon high speed centrifugation the respiratory activity in the supernatant fraction was resistant to irradiation while the respiration in the pellet fraction was photosensitive. This corresponded to the presence of cytochrome b$_{562}$ in the supernatant fraction and cytochrome b$_1$ in the pellet fraction. The inactivation was not reversed by the addition of quinone coenzymes. Difference spectra of the pellet fraction demonstrated that cytochrome b$_1$ was not reduced by NADH but was reduced by sodium dithionite. Partial purification of the cytochrome b$_1$ was attempted. Upon solubilization of the cytochrome b$_1$ the ultraviolet sensitivity was lost. If the solubilized preparation was allowed to stand to permit reaggregation the sensitivity was restored. Upon comparison of the NADH oxidase system with the nitrate reductase system similar results were observed. The cytochrome b$_1$ could not be enzymatically reduced but could be chemically reduced, by sodium dithionite. No ultraviolet inactivation of formate dehydrogenase or the nitrate reductase enzyme was observed. The kinetics of reduction of the undamaged cytochrome b$_1$ were not altered. The total cytochrome b$_1$ content of an extract, when chemically reduced, was oxidized at the same rate as an unirradiated preparation. These results suggested a lesion site near cytochrome b$_1$ but not actually at cytochrome b$_1$. The properties exhibited by the preparations indicate that the potential modifying protein described by other workers was involved. The actual mechanism of action of the ultraviolet light appeared to be mediated by a lipid component of the electron transport particle. This view was strengthened by the kinetics of inactivation which did not follow first order kinetics as would be expected with a single interaction. (Diss. Abstr.)

33574 PROTECTIVE ACTION OF FLAVINS ON ULTRAVIOLET IRRADIATED DNA. Roth, Daniel; Roth, David M. (New York Univ. Medical Center, N. Y.). J. Invest. Dermatol.; 58: No. 4, 233-7(Apr 1972).

A postulated capability of riboflavin and flavin mononucleotide to protect DNA from damage by far-ultraviolet irradiation was investigated in purified reaction mixtures and in cultured mammalian cells. Purified calf thymus DNA, admixed with flavin at approximately physiological ratios, was protected from undergoing irradiation-induced changes in spectral absorbance and viscosity compatible with those accompanying pyrimidine dimerization. Irradiation-induced changes in unprotected DNA were reversed by a subsequent treatment of the DNA with flavin in the presence of visible light. There was no apparent interaction between flavin and non-irradiated DNA. These results suggest that photoexcited flavin interacts directly with the ultraviolet photoproduct in DNA and does not function simply as an energy sink to dissipate photons absorbed by DNA. Cultured embryonic hamster cells were protected from ultraviolet-induced inhibition of growth by a preliminary exposure to relatively large amounts of flavin. This effect was not due to a vitamin-like promotion of cell growth by the flavin. The observation that flavin concentrated transiently in the cytoplasm of exponentially growing hamster cells during a 6 hr incubation period suggested that a shielding action may cooperate with the protective photochemical mechanism in vivo. It was concluded that flavins may function physiologically to protect the genetic material of tissues exposed to actinic radiations, and that when flavin levels in these tissues are inadequate, either because of nutritional deficiency or excessive intensity of irradiation, the damage which results may provide one pathogenetic avenue for the characteristic integumentary lesions of riboflavin deficiency disease. (auth)

33575 EFFECTS OF COMBINED HEAT AND IRRADIATION TREATMENT ON PECTIN METHYLESTERASE. Delincee, Henry (Institut fuer Strahlentechnologie, Karlsruhe, Ger.). Confructa; 15: No. 6, 366-75(1970).

The determining factor in the pasteurization of citrus juices is the inactivation of pectin methylesterase. The effect of a combined heat and irradiation treatment on this enzyme was studied. Technologically, a study of this enzyme in its natural environment would be the most useful, but lack of basic information on its radiation behavior, and also of the effect of the combined irradiation and heat treatment, prompted this study with experiments on simplified systems, such as buffer solutions of varying composition, some with added sucrose. A few experiments were also performed with orange juice at enzyme levels corresponding to the natural product. (auth)

33576 EFFECT OF GAMMA RADIATION ON POST-HARVEST BEHAVIOUR OF PEARS. Sattar, Abdus; Ali, Mumtaz; Khan, Ismail; Muhammed, Amir (Atomic Energy Centre, Lahore). Sci. Ind. (Karachi); 8: No. 3-4, 330-3(Sep-Oct 1971).

The effect of γ irradiation on ethylene production, ripening, and quality characteristics of pears was studied. Radiation doses (200 to 300 krad) suppressed the rate of ethylene production, thereby resulting in the delay of ripening of pears for two to three days. Doses higher than 300 krad affected the texture of the fruit resulting in the rapid deterioration of the samples. The biochemical analysis revealed that there was little effect on sugars, but ascorbic acid was adversely affected at higher doses. Irradiated fruits were rated better than unirradiated control. (auth)

33577 EFFECTS OF SOME CHEMICAL RADIOPROTECTORS ON MOUSE LIVER NICOTINAMIDE ADENINE DINUCLEOTIDE (NAD^+) AND NADH LEVELS. Calcutt, G.; Ting, S. M. (United Bristol Hospital, Eng.). Biochem. Pharmacol.; 21: No. 3, 415-18(1 Feb 1972).

The effects of the following radioprotectors on the NAD^+ and NADH levels in mouse liver were studied: (1) cysteamine (MEA), (2) cysteine, (3) 2 amino-ethylisothiouronium bromide hydrobromide (AET), (4) serotonin, (5) sodium monofluoroacetate. Results showed a fall in NAD^+ levels, probably due to a direct transfer of NAD^+ from cells to the surrounding medium, rather than a loss of NAD^+. Except in the case of serotonin, where there was a rise after 1h, the NADH levels showed little deviation from normal. (UK)

33578 STUDY OF RADIOSENSITIZATION OF DNA BY MENADIONE USING ESR. Morley, T. G. (Cambridge Univ., Eng.). Stud. Biophys.; 28: No. 2, 117-23(1971).

Earlier reports of the formation of a radiosensitive complex between DNA and 2-Me-1,4-naphthoquinone (menadione or "Mnd") have been re-examined and found to be incorrect. Mnd is found to modify the ESR spectrum of DNA irradiated at 77°K. (auth)

33579 STRUCTURAL AND FUNCTIONAL CHANGES IN IRRADIATED DNA. Jung, H.; Ullrich, M.; Kroger, H.; Petersen, E.; Hagen, U. (Kernforschungszentrum, Karlsruhe, Ger.). pp 199-206 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Aqueous solutions of DNA were irradiated with Co γ rays and the functional and structural changes in DNA were measured as a function of the frequency of strand breaks generated either by the indirect action of radiation or by incubation with DNase. When using single-stranded DNA of bacteriophage ΦX174 the infectivity in the protoplast system is lost by DNase incision as well as by radiation-induced breaks. The ability of double-stranded DNA to serve as a template for enzymatic RNA synthesis is not changed by DNase treatment, whereas single-strand breaks generated by irradiation cause a decrease in the priming ability of DNA. Further ultracentrifugal experiments showed that RNA is synthesized from the starting sites naturally occurring on the DNA molecule up to the nearest radiation-induced single-strand break. At the site of these breaks very often the base and/or sugar moiety is damaged, thus explaining the difference in the effects of single-strand breaks produced by both DNase and ionizing radiation. (auth)

33580 LINOLEATE MICELLES AS MODELS FOR RADIOBIOLOGICAL EFFECTS. Gebicki, J. M. (Macquarie Univ., North Ryde, Australia). pp 229-38 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Interest in the radiation chemistry of polyunsaturated fatty acids arose from earlier work with isolated mitochondria, which demonstrated simultaneous formation of peroxides in membrane lipids and cell lysis. Although these effects were produced by chemical catalysts, other studies with linoleate showed that, on irradiation, the molecules were oxidized and that lipid peroxides were formed. Irradiation of aqueous solutions of sodium linoleate at pH 11 showed that the soap oxidized rapidly in a chain reaction. The chain was long, provided that the system contained micelles. To investigate the possible role of this reaction in the initiation of biological radiation damage, the effects of various additives and of lower pH were studied. The G value for linoleate oxidation depended on the nature of electrolyte present only if the ions affected structure or stability of the micelles. Presence of sparingly soluble cholesterol or heptane in micellar solutions increased the G values, while 10^{-3}M methanol had no effect. Yields remained high when the pH was lowered, although irradiations at pH values between 6 and 12 produced a G value curve with several inflections. These probably correspond to phase transitions occurring during titration of linoleate. Studies of the mechanism of the chain reactions carried out at various dose-rates showed that below 1000 rad/h the rate of chain initiation determined the overall rate, while at higher dose-rates the slowest reaction occurred between the fatty-acid free radical and oxygen. It appears that radiation damage to linoleic and other polyunsaturated fatty acids may be important in initiation of biological changes, firstly because of the wide distribution of these compounds in organisms and secondly because of the high yields of free radicals produced. Studies with aqueous micellar systems are particularly relevant to possible damage to cell membranes which are thought to contain micelle-like regions. (auth)

33581 PHOTOACTIVATION OF UROCANASE IN PSEUDOMONAS PUTIDA: ACTION SPECTRUM. Roth, Dennis; Hug, Daniel H. (Veterans Administration Hospital, Iowa City, Iowa). Radiat. Res.; 50: No. 1, 94-104(Apr 1972).

Reports from this laboratory have shown that urocanase of Pseudomonas putida is photoactivated by uv light. In the present study, an action spectrum for photoactivation of purified inactive enzyme was determined. This spectrum shows a major peak at 275 nm and a secondary peak at 320 nm. Reciprocity of time and dose rate was obeyed within the limits tested. The absorption spectrum of α-ketobutyrate, the coenzyme of urocanase, has some resemblance to the action spectrum. Therefore, it is proposed tentatively that the coenzyme is the chromophore for photoactivation. When active urocanase was irradiated with light in the range from 240 to 310 nm, the enzyme was inactivated, the action spectrum showing a peak at 275-280 nm. Inactivation was not found above 320 nm. This spectrum corresponded closely with the absorption spectrum of a simple protein, suggesting that tyrosine or tryptophan may be the chromophore for inactivation. Urocanase has characteristics which could be relevant to enzymatic photoregulation by sunlight. (auth)

33582 EFFECT OF GAMMA RADIATION AND ACTINOMYCIN ON CORTISONE INDUCTION OF LIVER ENZYMES. Yatvin, Milton B.; Lamar, Carlos Jr.; Pitot, Henry C. (Veterans Administration Hospital, Madison, Wis. Univ. of Wisconsin, Madison). Proc. Soc. Exp. Biol. Med.; 139: No. 4, 1220-3(Apr 1972).

Ionizing radiation and actinomycin-D were employed in an attempt to gain further insight into the mechanisms by which cortisone induces hepatic tyrosine transaminase (L-tyrosine: 2-oxoglutarate aminotransferase, EC 2.6.1.5) and tryptophan pyrrolase (L-tryptophan: H_2O_2 oxidoreductase, EC 1.11.1.4). Administration of the antibiotic at a dose of 200 μg/kg resulted in slight inhibition of the induction of tyrosine transaminase and tryptophan pyrrolase. Concomitant gamma radiation (6000 R) markedly enhanced this inhibition, while irradiation of the animals without actinomycin administration had little or no effect on the basal or induced levels of the enzymes studied. N_2-dimethylene-actinomycin-C_3, an analogue of actinomycin-D which does not bind to DNA, had no effect on enzyme induction. (auth)

33583 EFFECT OF ENZYME-SUBSTRATE INTERACTION ON THE ULTRAVIOLET-PHOTOSENSITIVITY OF ARGINASE. Konev, S. V.; Voskresenskaya, L. G.; Bolotovskii, I. D.; Sheiko, L. M. Dokl. Akad. Nauk BSSR; 15: No. 12, 1133-5(Dec 1971). (In Russian).

A comparison was made of the photosensitivity, quantum yields of photolysis, and the photosensitized reduction of sulfhydryl groups in free arginase and its complex with arginine substrate. The substrate protected the enzyme from uv inactivation. There were photoproducts formed other than those resulting from irradiation of the free enzyme. The protective effect is believed to result from a change in the formation rate and the nature of photochemical end products in protein during conformational rearrangements that are controlled by the substrate. (tr-auth)

33584 EFFECT OF γ-RADIATION ON THE STRUCTURE AND FUNCTION OF ISOLATED RAT-LIVER TRANSFER RIBONUCLEIC ACID. Holland, J.; Skinner, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Int. J. Radiat. Biol.; 21: No. 4, 343-52(Apr 1972).

In rat-liver t-RNA γ-irradiated in dilute aqueous solution, structural changes were revealed by polyacrylamide gel electrophoresis. A new, fast-moving and non-dialysable component appeared, the relative amount of which was a function of both the radiation dose and t-RNA concentration during irradiation. Part of the structural damage remained masked but could be demonstrated by heat treatment. The t-RNA amino-acid acceptor activity showed different degrees of radiosensitivity, depending on whether irradiation took place in air, nitrogen, or nitrous oxide. It was suggested that the acceptor function was in the first place damaged by e^-_{aq}. The lysyl-t-RNA bond was also studied under similar experimental conditions. Irradiation produced both dissociation of the bond and a change in the binding force in the remaining, non-dissociative fraction. (auth)

33585 PROTECTION OF DNA MOLECULES OF CULTURED MAMMALIAN CELLS FROM RADIATION-INDUCED SINGLE-STRAND SCISSIONS BY VARIOUS ALCOHOLS AND SH COMPOUNDS. Roots, R.; Okada, S. (Univ. of Rochester, N. Y.). Int. J. Radiat. Biol.; 21: No. 4, 329-42(Apr 1972).

The addition of alcohols (methanol, ethanol, t-butanol, ethylene glycol, and glycerol), SH compounds (cysteamine, cysteine, and mercaptoethanol), and cystamine protected DNA molecules of mammalian cells from radiation-induced single-strand scissions. The protection afforded with these scavengers increased as their concentrations were increased, but always only up to a certain maximum. The maximum protection was the same for all the alcohols and cystamine, but another maximum was found for all the SH compounds. The extent of radiation-induced single-strand breaks can therefore be grouped into protectable and non-protectable fractions. In the protectable fraction, there was a linear relationship between the scavenger concentrations for half maximum protection and the reaction rate constants for the OH radical reacting with the scavengers. No such linear relationship was demonstrated with rate constants of H and e^-_{aq}. The following suggestions are made: that the protectable fraction was mostly of indirect action; that the OH radical played a major role in radiation-induced single-strand breaks of DNA in cultured mammalian cells; that a major protection mechanism in indirect action was radical scavenging (or a competitive reaction); and that the protection mechanism by SH compounds may consist of radical scavenging as well as some other type of reaction(s) resulting in radiation protection. (auth)

33586 PHYSICAL MEASUREMENT OF RADIATION DAMAGE TO COLIPHAGE T7 DNA. Hawkins, R. B.; Ginsberg, D. M. (Walter Reed Army Inst. of Research, Washington, D. C.). Biophys. J.; 11: No. 5, 398-413(May 1971).

Coliphage T7 was exposed to ^{60}Co gamma radiation while suspended in phosphate buffer or in phosphate buffer plus 0.001 M l-histidine. DNA was isolated from the phage by incubation with pronase, followed by extraction with cold phenol. The intrinsic viscosity of the DNA was measured as a function of radiation dose. The fraction of DNA molecules surviving radiation treatment with no double-strand breaks was measured from the radiation-induced heterogeneity of the DNA sedimentation boundary. From comparison of these measurements it is concluded that radiation introduces lesions other than double-strand breaks which affect the hydrodynamic properties of the DNA. In both buffer and buffer plus histidine the surviving fraction of intact virus genomes far exceeds the surviving fraction of plaque-forming units at any given dose. It was found that the decrease in intrinsic viscosity with dose is independent of the presence of histidine in the radiation medium. From this it is concluded that DNA damage is primarily due to a direct effect of radiation on the phage particle. The procedure necessary to isolate DNA from irradiated virus suggests that radiation produces covalent bonding of protein to the DNA. (auth)

33587 NATURE OF THE COMPLEMENTARY STRANDS SYNTHESIZED IN VITRO UPON THE SINGLE-STRANDED CIRCULAR DNA OF BACTERIOPHAGE φX174 AFTER ULTRAVIOLET IRRADIATION. Poddar, Ramendra K.; Sinsheimer, Robert L. (California Inst. of Tech., Pasadena). Biophys. J.; 11: No. 4, 355-69 (Apr 1971).

Experiments intended to decide whether uv lesions in DNA act as absolute blocks to chain elongation by the Escherichia coli DNA polymerase or only slow down the polymerization process are described. Ultraviolet (uv)-irradiated, single-stranded (SS) circular DNA of bacteriophage φX174 was used as template for the polymerase in a reaction mixture in vitro, under conditions allowing synthesis of not more than one complementary strand per template molecule. The mean length of the newly synthesized complementary strands (as determined by velocity sedimentation in alkaline CsCl gradients), as well as the over-all template activity (as measured by deoxyadenosine monophosphate [dAMP] incorporation) was found to decrease with the number of biologically lethal hits sustained by the irradiated templates. With the increase of time or temperature of reaction, the net synthesis of complementary strands increased (as a consequence of increased initiation), but their mean length remained constant. The mean length of synthesized strands was greater than would be expected if all biologically lethal hits were to block the polymerization process. The lethal hits which serve as blocking lesions are inferred to be pyrimidine dimers because it is possible to obtain synthesis of full-length complementary strands if, when heat-denatured, uv-irradiated, double-stranded replicative form (RF II) DNA of bacteriophage φX174 is used as a template, it is pretreated with yeast photoreactivating enzyme (YPRE) in presence of visible light. (auth)

33588 DINITROPHENOL INHIBITS THE REJOINING OF RADIATION-INDUCED DNA BREAKS BY L-CELLS. Moss, A. J. Jr.; Dalrymple, Glenn V.; Sanders, J. L.; Wilkinson, K. P.; Nash, John C. (Univ. of Arkansas, Little Rock. Veterans Administration Hospital, Little Rock, Ark.). Contract AT(40-1)-3884. Biophys. J.; 11: No. 2, 158-74(Feb 1971).

The production and rejoining of x-ray-induced single-stranded DNA breaks was studied using the alkaline sucrose density gradient technique and by measuring the disappearance of both 5′ termini and 3′-OH termini using polynucleotide kinase and DNA polymerase, respectively. All studies were conducted using L-cell suspensions irradiated both in the presence and absence of 2,4-dinitrophenol (DNP), an uncoupler of oxidative phosphorylation. Results show that the induction of single-stranded DNA breaks probably includes a nucleolytic component in addition to indirect free radical effects. A greater number of breaks were produced in the absence of DNP, suggesting that depressed adenosine triphosphate (ATP) levels reduce endogenous nucleolytic activity. The rejoining mechanism is enzymatic and requires an available ATP supply for operation. In the presence of DNP no DNA rejoining was observed following 30 min incubation after 10,000 rad. These results suggest that DNA breaks produced may be characterized by 5′-PO_4–3′-OH termini and are rejoined by DNA ligase. (auth)

33589 DEOXYRIBONUCLEIC ACID SYNTHESIS IN ULTRAVIOLET-LIGHT-IRRADIATED CHINESE HAMSTER CELLS. Meyn, Raymond E.; Humphrey, Ronald M. (Univ. of Texas, Houston). Bophys. J.; 11: No. 3, 295-301(Mar 1971).

Two mammalian cell lines, Chinese hamster ovary (CHO) which can recover colony-forming ability between fractionated doses of ultraviolet light (uv), and Chinese hamster B-14FAF28 which cannot recover, were tested for the ability to bypass uv-induced photoproducts in DNA during postirradiation DNA synthesis. The molecular weight distributions of newly synthesized DNA in uv-irradiated populations of both cell lines showed evidence for photoproduct bypass. Hence, the bypass mechanism does not correlate with recovery after uv. (auth)

33590 DEPENDENCE OF SINGLE-STRANDED DNA LENGTH ON STAGE OF GROWTH CYCLE IN ESCHERICHIA COLI B/r AND EFFECT OF IRRADIATION. Lehnert, Shirley; Moroson, Harold (Sloan-Kettering Inst. for Cancer Research, New York). Contract AT(30-1)-910. Biophys. J.; 11: No. 10, 798-809(Oct 1971).

Alkaline sucrose density gradient profiles of DNA from log phase Escherichia coli B/r (CSH) show a main peak with sedimentation coefficient at approximately 130S and a shoulder or second peak at approximately 90S. Incorporation of radioactive precursors into the 90S peak precedes their appearance in the main peak. The size of the second peak appears to be directly related to the rate of replication and it is not present in profiles of nondividing stationary phase cultures. The decrease in weight average molecular weight (Mw) of DNA produced by x-rays is also directly related to the rate of replication. It is greatest in log phase E. coli B/r and least in stationary phase cells, because of the efficiency of rejoining of radiation-induced single strand breaks in DNA of the latter cells. (auth)

33591 STABILITY OF 5′-RIBONUCLEOTIDES IN γ IRRADIATED SOLUTION. Terada, Junko; Hata, Keiko; Mouri, Takenori; Hashida, Wataru; Shiga, Iwao (Toyo Junior Coll. of Food Tech., Kawanishi, Japan). Toyo Shokuhin Kogyo Tanki Daigaku, Toyo Shokuhin Kenkyusho Kenkyu Hokokusho; No. 9, 221-30(Mar 1970). (In Japanese).

Some of the nucleotides such as 5′-IMP and 5′-GMP have been found to play an important part in the flavor-enhancement of foodstuffs. In order to investigate the stability of nucleotides to γ irradiation, solutions containing nucleotides were sealed in glass ampules and irradiated with a 5,000 curie ^{60}Co source. Remaining nucleotides were assayed for the amount of phosphoric acid liberated by the action of 5′-nucleotidase. With the increasing dose of irradiation, pH of 5′-IMP solutions reduced accompanied by the decrease of remaining 5′-IMP. A linear relation existed between the logarithmic amount of remaining 5′-IMP and the irradiation dose (from 1 to 10 Mrad). 5′-IMP was stable at pH 9 but less stable at pH 3 or 5. Purine nucleotides are more stable than pyrimidine nucleotides. Food components, such as glucose, sucrose, casein hydrolyzate, or sodium chloride, were added to the 5′-IMP solutions and irradiated at 1 Mrad. Glucose, sucrose, and casein hydrolyzate exerted an inhibitory effect on the decomposition of 5′-IMP. Hypoxanthine is the main decomposition product during irradiation of 5′-IMP at pH 3 and 5, whereas, at pH 9, inosine and hypoxanthine are formed. From these results it is assumed that the decomposition mechanism of 5′-nucleotides with γ irradiation is quite different from that with heat sterilization. (auth) (Japan)

33592 INHIBITION BY X-RAYS OF THE EFFECT OF SUCCINATE CYTOCHROME C REDUCTASE ON MITOCHONDRIA IN AN IN VITRO CULTIVATED EMBRYONIC CHICKEN ORGAN. Gasc, J. M. (Centre National de la Recherche Scientifique, Nogent-sur-Marne, France. College de France, Nogent-sur-Marne). Compt. Rend., Ser. D; 274: No. 5, 723-5(31 Jan 1972). (In French).

X rays have an inhibiting effect on the enzymatic action of succinate cytochrome C reductase in an in vitro cultivated embryonic chicken organ. The inhibiting action is proportional to the logarithm of the radiation dose in the 600 to 6000R range when the activity of the mitochondria extracted from organs 16h after irradiation is measured. (France)

33593 INHIBITION PRODUCED BY X-RAYS AND THE RADIOPROTECTION QUALITIES OF SUCCINATE CYTOCHROME C REDUCTASE THAM IN THE MITOCHONDRIES OF AN EMBRYONIC ORGAN. Reinbold, Michel; Gasc, J. M. (Centre National de la Recherche Scientifique, Nogent-sur-Marne, France. College de France, Nogent-sur-Marne). Compt. Rend., Ser. D; 274: No. 6, 932-5(7 Feb 1972). (In French).

X rays have an inhibiting action on the enzymatic activity of mitochondria. This action is partly due to the low pH of the external medium and may be hidden by the permeabilization of the membranes, observed after irradiation. THAM, with a permeability of 7.4, has important radioprotection qualities. (France)

33594 DAMAGE TO BIOLOGICAL SAMPLES CAUSED BY THE ELECTRON BEAM DURING ELECTRON MICROSCOPY. Thach, Robert E.; Thach, Sigrid S. (Univ., Geneva. Harvard Univ., Cambridge, Mass.). Biophys. J.; 11: No. 2, 204-10(Feb 1971).

A new method has been developed which measures directly the beam damage suffered by biological specimens in the electron microscope. This method involves the use of radioautography to measure specific radioactivity of labeled specimens, either exposed or unexposed to the beam. Using this technique, it has been found that macromolecular samples such as ribosomes and R17 virions are severely damaged during standard electron microscopic operations: from 15 to 40% of the mass of the sample may be lost in a 30 sec exposure to the beam. (auth)

33595 MECHANISM OF POST-IRRADIATION DEGRADATION OF DEOXYRIBONUCLEIC ACID IN A RADIOSENSITIVE ESCHERICHIA COLI (NG30) IRRADIATED WITH ULTRAVIOLET LIGHT. Yonei, Shuji; Nozu, Keiichi (Osaka Univ.). J. Mol. Biol.; 65: No. 2, 213-25(28 Mar 1972).

The post-irradiation degradation of DNA in a radiosensitive mutant, NG30, of Escherichia coli, was investigated. An extensive degradation of DNA corresponding to the ultraviolet dose was observed. The post-irradiation degradation of DNA having no replicating points is not initiated from a specific point in the DNA, but does occur simultaneously at many sites of the irradiated DNA. The proposal that the initial cause for DNA degradation is the excision of pyrimidine dimers was supported by the following experimental results: an immediate fragmentation of cellular DNA was observed in the cells shortly after ultraviolet irradiation by an alkaline sucrose-gradient analysis; pyrimidine dimers were detected in the acid-soluble fraction from the cells incubated for only five minutes after ultraviolet irradiation; post-irradiation degradation of DNA was markedly suppressed in a double mutant of E. coli, NG30uvrC; and caffeine significantly inhibited the post-irradiation degradation of DNA. It is also shown that the extensive DNA degradation which follows must result from the unsuccessful repair of gaps in the DNA strands produced by excision of pyrimidine dimers. (auth)

33596 CHARACTERISTICS OF THE RADIATION-INDUCED DEGRADATION OF DNA IN ESCHERICHIA COLI. Myers, D. K. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Microbiol.; 18: No. 5, 647-54(May 1972).

The degradation of DNA in bacterial cells was studied in two strains of Escherichia coli after exposure to x-radiation, ultraviolet (uv), or methyl methanesulfonate. The degradative system functions differently in freshly harvested growing cells and in cells which have been aged by standing for 2 days at room temperature in saline-phosphate. Growing cells degrade their DNA most effectively at low doses of x-radiation and require a factor whose synthesis is inhibited by chloramphenicol; these cells also degrade DNA after exposure to uv radiation. Aged cells degrade their DNA most effectively at high x-radiation doses, do not require the chloramphenicol-sensitive factor, and no longer respond to uv irradiation. Together with data on effects of freezing, of cold-water, and of various inhibitors, the above results suggest that the system responsible for radiation-induced degradation of DNA is dependent on structural organization in the intact cell. (auth) (Canada)

33597 RESPONSE OF SOME NUCLEOTIDES IN VIVO TO GAMMA RADIATION ON EUGLENA CELLS IN TWO DIFFERENT GROWTH PHASES. Matsuoka, Saburo (Gifu Univ., Japan). Bull. Inst. Chem. Res., Kyoto Univ.; 50: No. 1, 38-44(Jan 1972).

A mode of radiation effect was compared by means of the column chromatographic investigation of intracellular nucleotides between logarithmic phase cells and stationary phase ones. Radiation dosage used was 1×10^5 R gamma rays of ^{60}Co. The nucleosides were more easily broken by the irradiation than the nucleotides. The nucleotides increased in quantity after the irradiation in the case of monophosphate, but decreased in quantity in di- and tri-phosphates. This tendency was observed markedly in stationary phase cells in comparison with logarithmic phase cells. (auth)

33598 EFFECT OF IONIZING RADIATION ON ACTIVITY OF GLUCOSE-6-PHOSPHATE-DEHYDROGENASE. Ghizari, Eugenia. Rev. Roum Physiol.; 9: No. 1, 63-8(1972). (In French).

The activity of glucose-6-phosphate-dehydrogenase was studied in mice treated with 50, 100, 250, and 500 R of x radiation. The enzyme in the erythrocytes shows the most pronounced variations after a 100 R dose; they are expressed by an activation during the first 24 hrs after irradiation followed by a return to control values. The modifications observed after other doses are insignificant. The activity in the brain also increased during the first hrs after administration of 50 and 100 R; a dose of 500 R produced at first a slight inhibition that was considerably accentuated toward the end of the period of analysis. The activity in the liver also increased following 50 and 100 R doses. A dose of 250 R inhibited distinctly the activity of the enzyme after three hrs, an effect that persisted to the end of the period of observation. (tr-auth)

33599 CYTIDINE PHOTOHYDRATION IN R17 RNA. Mattern, Michael; Binder, Ralph; Cerutti, Peter (Univ. of Florida, Gainesville). J. Mol. Biol.; 66: No. 1, 201-4(28 Apr 1972).

A reductive assay for the determination of cytidine photohydrates (6-hydroxy-5,6-dihydrocytidine) in ultraviolet-irradiated RNA was developed. The assay is based on the transformation of the unstable photohydrate into the stable reduction product N_1-ribosyl-N_3-(γ-hydroxypropyl)-urea in the irradiated RNA. The irradiated and reduced RNA is enzymically hydrolyzed and the hydrolysate is analyzed by ion-exchange chromatography. The results with R17 RNA show that cytidine photohydration occurs with 10 to 15 times lower efficiency than uridine photohydration. It is estimated that, at D_{37} (i.e., the ultraviolet dose necessary to decrease the infectivity to 37%) R17 RNA contains only about 0.1 cytidine photohydrate. (auth) (UK)

Radiation Effects on Cultured Cells (External Source)

Refer also to abstracts 33574, 33585, 33588, 33628, 33703, 33747, 33764, and 35208.

33600 (AEC-tr-7303, pp 33-41) ION TRANSPORT AND ENERGY METABOLISM IN IRRADIATED ERYTHROCYTES. Nakhil'nitskaya, Z. N.; Gerasimova, G. K.; Strzhizhovskii, A. D. Translated from Radiobiologiya; 11: No. 3, 345-50(May-Jun 1971).

In an investigation of countergradient transport of K ions in vitro in rat erythrocytes, an increase in the transport coefficient (K_{ab}) dependent on the dose of irradiation directly after the influence and a decrease in K_{ab} by the sixth hour of postradiation incubation (37°) were found. The concentrations of ATP, ADP, and AMP did not differ from the control during the first hour after irradiation; by the sixth hour a decrease in ATP in the cells irradiated at a dose of 100 to 150 kR was noted. In the presence of NaF and MIA, the ATP level was lowered both in the control and in the irradiated erythrocytes, and the appearance of a phase of increase in K_{ab} was also prevented. Means of influence of radiation on the transport function of the erythrocyte membranes are discussed. (tr-auth)

33601 (AEC-tr-7303, pp 51-6) STUDY OF THE EFFECT OF FRACTIONATED X IRRADIATION IN A TISSUE CULTURE OF EMBRYONIC HUMAN FIBROBLASTS. Lyubimova, T. P.; Tarasov, V. A. (Inst. of General Genetics, Moscow). Translated from Radiobiologiya; 11: No. 3, 357-61(May-Jun 1971).

A primary culture of human embryonic fibroblasts was subjected to fractional irradiation in a dose of 100 R with two identical fractions of 50 R each, with intervals of 0, 7, 15, 30, and 60 min between them. A different nature of the variation of the level of aberrant cells during fractionated irradiation was observed, depending on the period of fixation of the material after irradiation. During the first periods (8 to 16 hrs), a wave-like dependence of the cytogenetic effect of fractionated irradiation was obtained; in later periods (20, 30 hrs) there was no such wave-like variation, with a statistically significant increase in this effect in the case of fractionation of the dose in comparison with a single irradiation (at the period of fixation 25 hrs). (tr-auth)

33602 (AEC-tr-7303, pp 86-91) VARIATION OF THE VALUE OF THE OXYGEN EFFECT AT VARIOUS DOSES OF X IRRADIATION AND ITS POSSIBLE CLINICAL SIGNIFICANCE. Reves, L.; Littbrand, B. (Caroline Inst., Stockholm). Translated from Radiobiologiya; 11: No. 3, 383-6(May-Jun 1971).

Oxygen, being a radiomodifying agent, either intensifies the lesion or reduces it, promoting a recovery of cells from sublethal damages. The final result of an increase in the effectiveness of recovery and an increase in cell damage determines the positive or negative oxygen effect and depends on the value of the irradiation dose. The dependence of the oxygen effect on the value of the irradiation dose and degree of oxygenation of the tumor can be used for the rational construction of a course of radiation therapy of tumors. Results are reported from studies on x-irradiated cultured Chinese hamster and Ehrlich ascites carcinoma cells. (tr-auth)

33603 (AEC-tr-7303, pp 129-39) ANALYSIS OF THE DEPENDENCE OF THE SHAPE OF THE SURVIVAL CURVE ON THE TYPE OF RADIATION. Kapul'tsevich, Yu. G.; Parfenov, E. N.; Petrosyan, L. P. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 3, 413-20(May-Jun 1971).

Survival curves, sigmoid at a low linear energy transmission (LET) of radiations and exponential at a high LET, are analyzed from the standpoint of the hit principle. It was shown that the change in the survival curves of mammalian cells with increasing LET is in qualitative agreement with the multihit model, in which the event of a hit corresponds to the formation of several primary ionizations in the sensitive structure of the cell by one ionizing particle, and the number of such structures in the cell should be rather large. The hypothesis that a hit is one pair of ions or one primary ionization contradicts the experimental data obtained in experiments with mammalian cells. The results of the calculations give evidence that the concept of the threshold local energy density is also inapplicable to the analysis of the results of these experiments. (tr-auth)

33604 (BNL-16663) DNA LESIONS AND MAMMALIAN CELL KILLING: CAUSE AND EFFECT? Elkind, M. M.; Ben-Hur, Ehud (Brookhaven National Lab., Upton, N. Y.). [1972]. 35p. (CONF-720115-1). Dep. NTIS.

From Symposium on molecular basis of radiation biology; Jerusalem, Israel (3 Jan 1972).

Studies of repair mechanisms were conducted with regard to the sensitive sites in a cell. This approach has been used with mammalian cells based on the fact that sublethal damage must be accumulated to kill a cell and the observation that cells can repair sublethal damage. Actinomycin D was found to inhibit this repair, an observation which justified a focus upon nuclear DNA as the site of damage and repair. Sedimentation studies with alkaline gradients revealed two repair processes. Repair of single-strand breaks (also found by others) and repair to a complex of DNA, lipid, and protein. In cells sensitized to fluorescent light because of prior growth in the presence of 5-bromodeoxyuridine, the data suggest that single-strand breaks is the lethal lesion. In contrast, damage to a DNA-membrane structure appears a more likely target for x-ray cell killing. (auth)

33605 ROLE OF PERIODS OF THE MITOTIC CYCLE IN LETHAL DAMAGES INDUCED BY GAMMA-IRRADIATION. Komolov, I. S.; Gubin, V. A.; Samoilova, E. M.; Piskus, N. M. (Inst. of Biophysics, Moscow). Stud. Biophys.; 28: No. 2, 111-15(1971).

Monkey heart cells were cultured in Petri dishes and gamma-irradiated in doses of 100 to 750 R. It was found that cells in the M phase were the most radiosensitive; after entering the G_1 phase the cells rapidly became very resistant. Mean lethal doses for different phases of the mitotic cycle are given. Monkey heart cells are compared with HeLa cells with respect to effects of cell phase on radiosensitivity. Possible mechanisms of changes in radiosensitivity are discussed. (H.L.W.)

33606 DNA SYNTHESIS IN MAMMALIAN CELLS EXPOSED TO COMBINED IONIZING AND NON-IONIZING RADIATION. Brown, J. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp 187-98 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Synthesis of DNA was investigated in mammalian cells exposed sequentially to combined doses of x rays and ultraviolet radiation (uv). Cultures of Chinese hamster cells and human peripheral blood leukocytes were exposed in vitro to fixed doses of x rays, followed immediately by graded doses of ultraviolet, and to fixed doses of ultraviolet followed immediately by graded doses of x rays. Tritium-labelled cells were examined by liquid scintillation counting and autoradiography. Over the dose range studied, it was found that the inhibition of DNA synthesis observed in Chinese hamster cells pre-sensitized with uv and then x-irradiated was greater than in cells given the same total dose in the sequence x, uv. The difference in synthesis was detectable with an ultraviolet dose as low as 20 ergs/mm^2. In phytohaemagglutinin-stimulated cultures of human leukocytes it was found that the total inhibition of DNA synthesis of the combined dose of radiation was approximately the same as the inhibitions of the two types of radiation applied as separate doses. Contrary to the findings with hamster cells, no significant difference was detected for the sequence of the combined dose. (auth)

33607 INACTIVATION OF MAMMALIAN CELLS AT DIFFERENT STAGES OF THE CELL CYCLE AS A FUNCTION OF RADIATION LINEAR ENERGY TRANSFER. Bird, R.; Burki, J. (Univ. of California, Berkeley). pp 241-50 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The response of mammalian cells to different LET radiations from charged particle beams as a function of the time of irradiation in the cell cycle was investigated. Chinese hamster cells (V79) were grown in cell culture, and were synchronized without the use of drugs by selective shake-off of mitotic cells from the culture. After the cells had re-attached to a surface they were irradiated with x rays (150 kV) or with charged carbon, neon, or argon ions at different times during a growth cycle. The colony-forming ability was measured after 6 d. In addition, aliquots of the cells were used to determine the labeling index, mitotic index, and colony multiplicity as a function of time. The x ray survival curves of the cells exhibited a sensitive period in the G_1 stage, a more resistant period during the late S stage, and an increased sensitivity after the S stage of the cycle. The cells irradiated with carbon, neon, or argon exhibited no such response and remained equally sensitive throughout the experimental period. The survival curves with these ions had an absence of a shoulder throughout the life cycle. Since the age response of these mammalian cells appears constant throughout the cycle the results suggest a further possible therapeutic value of high LET beams in that cell kinetics are much less important for the timing of radiation exposure. In addition, these results have obvious implications to considerations of the effects of heavy primary cosmic-ray particles on astronauts in long-term space flight. (auth)

33608 CORRELATION BETWEEN DIVISION DELAY AND LOSS OF COLONY-FORMING ABILITY IN CULTURED CHINESE HAMSTER CELLS. Cormack, D. V.; Froese, G. (Manitoba Cancer Treatment and Research Foundation, Winnipeg). pp 251-9 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The multiplication of Chinese hamster cells (V79) before and after γ irradiation was recorded on 16mm film using a multiple-position time-lapse system. By projecting the film it was possible to determine the times at which new cells appeared and to follow the growth of several individual micro-colonies from the doubled stage, in which the cells were irradiated, until a macroscopic colony was formed (>50 cells) or until the cells disintegrated. From the data it was possible to calculate the mean generation times of pairs of cells irradiated in various ways and of unirradiated cells. Before being placed in one of the two sealed growth chambers, cells were partially synchronized using selective detachment of mitotic cells and were irradiated at various subsequent times. For cells irradiated with 250, 500 or 1000 rad during the early part of the cell cycle, the first post-irradiation division of non-colony formers (cells which subsequently failed to form a macroscopic colony within six days) occurred later, on the average, than that of colony-forming cells. The average duration of subsequent cell generations was also examined. It was found that the average time between the first and second post-irradiation divisions was shorter than the duration of the preceding generation, i.e., both colony-forming and non-colony-forming cells showed some recovery from division delay. The above results will be used to develop and test various models for the radiation-induced loss of colony-forming ability. (auth)

33609 CHROMOSOME ABERRATIONS IN CHINESE HAMSTER CELLS FOLLOWING EXPOSURE TO X-RAY AND ULTRAVIOLET RADIATION. Brown, J. K. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp 273-86 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

A chromosomal analysis was made of tritium-labelled asynchronous Chinese hamster cells exposed in vitro to 250-kV x rays (dose 400 R), ultraviolet light (uv) 2537 Å (dose 50 ergs/mm^2), a combination of both types of radiation (200 R + 50 ergs/mm^2, 400 R + 50 ergs/mm^2) or no radiation. An additive effect only was observed for chromosomal aberrations in G_2 cells exposed to combined doses of x and uv, radiation whereas for chromosome aberrations in G_1 and S cells a pronounced synergistic effect was observed. Complex chromatid exchanges accounted for most of the additional aberrations in G_1 and chromatid breaks and exchanges for the increased frequency in S phase. The results indicate the highly complex nature of chromosomal damage by different forms of radiation. (auth)

33610 RADIATION DAMAGE TO LYMPHOCYTES: ITS EXPRESSION IN THE KINETICS OF SHORT-TERM CULTURE. Ilbery, P. L. T.; Rickinson, A. B. (Univ. of Sydney). pp 297-310 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The proliferative response of human blood lymphocytes exposed to the mitogen phytohemagglutinin (PHA) was studied following incremental doses of ^{60}Co gamma radiation to leukocyte cultures. Lymphocyte response was measured as uptake of ^3H-thymidine in cultures labeled 48 and 72 h after the addition of PHA. Uptake was expressed as the total incorporation into DNA per standard number of lymphocytes initially present or as the percentage of cells labeled in autoradiographs in these cultures. Irradiation of cultures caused well-marked depression in precursor uptake compared with unirradiated controls, and both parameters of lymphocyte response showed reproducible dose-effect curves in the range 250 to 2000 rad under standardized experimental conditions. The factors affecting reproducibility are enumerated and the cell-cycle kinetics of irradiated cultures will be discussed. It is thought that the changes in DNA precursor uptake reflect a true radiation-induced depression of lymphocyte replicating ability and the feasibility of using the altered growth kinetics of short-term lymphocyte cultures as a biological dosimeter of radiation exposure is examined. To this end the in-vitro response to PHA of lymphocytes from donors undergoing radiotherapy was studied before, during, and after their course of treatment, and on each occasion compared with that shown by cultures from the same healthy individual. A number of patients receiving high integral dosage over a large volume containing major blood vessels were subjected to depressions of lymphocyte response which from both the above parameters appeared equivalent to that seen in cultures from healthy donors following several hundred rad in-vitro radiation. (auth)

33611 VARIOUS EXAMPLES FROM CELLULAR KINETICS SHOWING HOW RADIATION QUALITY CAN BE ANALYSED AND CALCULATED BY THE TWO-COMPONENT THEORY OF RADIATION. Wideroee, R. pp 311-30 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The two-component theory of radiation injury of biological materials is based upon a simplified model of the LET spectrum and the corresponding biological reactions. Radiation quality for a specific type of radiation (^{210}Po α particles, ^{90}Y β particles, high energy charged particles, 20 keV x rays, and 200 keV x rays) can thus be described by means of a single constant α, the relative part of the high LET component. In this way, it is possible to understand and calculate empirical terms such as RBE and OER (oxygen enhancement ratio). The following examples will show the use of this method: Cell survival curves of irradiated mammalian cell cultures; influence of oxygen concentration on cell cycle; and the influence of different phases of the cell cycle. (auth)

33612 COMPARATIVE EFFECTS OF NEUTRONS AND X-RAYS ON CHINESE HAMSTER CELLS. Key, M. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp 431-44 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

On the basis of the RBE-LET relationship derived mainly from heavy ion irradiation, the neutron RBE is expected to be a maximum at energies below 1 MeV. An attempt was made to derive neutron RBE for various energies between 14 and 500 keV, and for a fast neutron spectrum with energies up to 6 MeV. A Van de Graaff accelerator was used to produce the beams of low and high energy neutrons by the $^7Li(p,n)^7Be$ and $^7Be(d,n)^{10}B$ reactions, respectively. The very low dose-rates of the neutrons from the lithium target severely limited the maximum dose which could be achieved. Chinese hamster cells in vitro were irradiated with neutrons or 250-kV x rays and the damage was assessed by measuring cell survival and chromosome aberrations, as a function of dose. The pulse labeling technique with ^3H-thymidine was used to discriminate between different stages of the cell cycle for the chromosome aberration studies. The neutron RBE was derived by comparing the neutron and x ray dose-response curves. Generally the neutron RBE values varied from about 2 to 50 with a clear dependence on neutron energy indicated. The RBE was consistently higher for G_1 aberrations than for G_2 aberrations, and this may be explained by the cell's greater capacity for repair after x ray damage than after neutron damage. The possible application of these results to neutron QF is discussed. (auth)

33613 RADIATION RESPONSE OF A LONG-TERM CULTURE OF HUMAN LYMPHOID CELLS. I. ASYNCHRONOUS POPULATIONS. Drewinko, B.; Humphrey, R. M.; Trujillo, J. M. (Univ. of Texas, Houston). Int. J. Radiat. Biol.; 21: No. 4, 361-73(Apr 1972).

The radiation response of a long-term culture of human immunoglobulin-producing lymphoid cells (T_1 cells) studied by the colony-forming method was remarkably similar to the response of other mammalian cell cultures. The relevant parameters were: n = 7 to 8; $D_q = 175$ rads, and $D_0 = 85$ rads. The cells demonstrated the ability to repair x-ray damage when the total dose was delivered in two separate exposures. Repair resulted in the restitution of the shoulder region in dose-dependent survival curves. T_1 cells, as an in vitro model for the radiation response of lymphoid cells, contradicted the classical contention that immunocytes are extremely radiosensitive. (auth)

33614 CELL POPULATION KINETICS OF PISUM ROOT MERISTEM CELLS DURING AND AFTER A MITOTIC-INHIBITORY EXPOSURE TO PROTRACTED GAMMA-IRRADIATION. Burholt, Dennis R.; Van't Hof, Jack (Brookhaven National Lab., Upton, N. Y.). Int. J. Radiat. Biol.; 21: No. 4, 307-19(Apr 1972).

Primary root meristems of Pisum sativum with a mitotic cycle prolonged to about 36 hr by lowering the temperature to 10°C exhibited complete mitotic inhibition after 3 days of exposure to gamma radiation at a rate of 0.83 R/min. ^{3}H-thymidine autoradiography, ^{3}H and ^{14}C double-labeling autoradiography combined with Feulgen microspectrophotometry, and the colchicine-induced tetraploid technique were used to measure the cell population parameters. After mitotic inhibition occurred, cells accumulated in G1 and G2 with some cells passing through S, and with time under irradiation cells moved at a reduced rate out of G1, through S, and into G2, where they stopped cycle progression. After termination of irradiation, cells that were in G1 and S during irradiation were capable of division, whereas cells in G2 were not. Two extra days of exposure did not reduce the rate at which cells flowed from G1 → S after irradiation, but did not produce a delay in the appearance of these cells in M. The first complete post-irradiation mitotic cycle was of slightly shorter duration than control and there was an indication that a compensatory proliferative reaction took place in order to repopulate cells lost from the meristem. (auth)

33615 ULTRAVIOLET LIGHT-INDUCED DIVISION DELAY IN SYNCHRONIZED CHINESE HAMSTER CELLS. Han, Antun; Sinclair, Warren K.; Yu, C. K. (Argonne National Lab., Ill.). Biophys. J.; 11: No. 6, 540-9(Jun 1971).

The age-dependent, ultraviolet light (UVL) (254 nm)-induced division delay of surviving and nonsurviving Chinese hamster cells was studied. The response was examined after UVL exposures adjusted to yield approximately the same survival levels at different stages of the cell cycle, 60% or 30% survival. Cells irradiated in the middle of S suffered the longest division delay, and cells exposed in mitosis or in G_1 had about the same smaller delay in division. Cells irradiated in G_2, however, were not delayed at either survival level. It was further established, after exposures that yielded about 30% survivors at various stages of the cycle, that surviving cells had shorter delays than nonsurvivors. This difference was not observed for cells in G_2 at the time of exposure; i.e., neither surviving nor nonsurviving G_2 cells were delayed in division. The examination of mitotic index vs time revealed that most cells reach mitosis, but all of the increase in the number of cells in the population can be accounted for by the increase of the viable cell fraction. These observations suggest strongly that nonsurviving cells, although present during most of the experiment, are stopped at mitosis and do not divide. Cells in mitosis at the time of irradiation complete their division, and in the same length of time as unirradiated controls. Division and mitotic delays after UVL are relatively much larger than after x ray doses that reduce survival to about the same level. (auth)

33616 REPAIR PROCESSES AND CELL SURVIVAL. Laurie, Jean; Orr, J. S.; Foster, C. J. (Western Regional Hospital Board, Glasgow. Glasgow Inst. of Radiotherapeutics). Brit. J. Radiol.; 45: No. 533, 362-8(May 1972).

A model of cell survival after irradiation is presented based on Powers' suggestion of a "pool," developed along the lines initiated by Lajtha and Oliver (Brit. J. Radiol. 34: 252-7). The repair process corresponding to the shoulder on the survival curve is distinguished from the process demonstrated by the initial rise observed in the recovery curve. The two processes are separated by the existence of a limited pool of intracellular constituents or states. The time course of the processes of repair or development of damage is expressed in equations which are solved to give the relation between the dose and the final survival observed. The model includes the situation during low dose-rate irradiation when the rate of replenishment of the pool is equal to the rate of depletion due to repair. This is used to analyze experimental results obtained for acute and protracted irradiation. The values of the parameters found can be used in the prediction of the effects of protracted irradiation at other dose-rates. The experimental and conceptual reasons for identifying a repair process other than the well-known Elkind recovery are discussed. The usefulness of the model is demonstrated for the study and prediction of four types of phenomenon: those associated with the size of the pool, the interaction of different agents through the medium of the pool, the rate of action of the pool, and the effects of protracted irradiation. (UK)

33617 COMPARATIVE STUDY OF RADIOSENSITIVITY OF MACACA MULATTA PERIPHERAL BLOOD LYMPHOCYTE CHROMOSOMES AT DIFFERENT IRRADIATION DOSES. Dzhemilev, Z. A.; Machavariani, M. G. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Genetika; 8: No. 1, 113-19(Jan 1972). (In Russian).

Chromosome radiosensitivity was studied in the primary culture of Macaca mulatta peripheral blood lymphocytes after the culture irradiation at doses of 25, 50, 100, 200, and 400 R. The cultures were fixed at the first mitosis at the 50th hr of growth. Chromosome aberrations were determined in metaphase cells. The number of cells bearing chromosome aberrations and the number of paired acentric fragments was found to increase linearly in relation to irradiation dose. The number of dicentrics and rings increased in proportion to the quadrate dose. The data obtained show that number of chromatid type aberrations at the investigated range of doses does not depend on irradiation dose and is near to the spontaneous level. The frequency of induced chromsome breaks increased with increasing of the dose. (auth)

Radiation Effects on Microorganisms (External Source)

Refer also to abstracts 33562, 33564, 33586, 33587, 33590, 33595, 33597, 33688, 33703, 33743, 33744, and 33807.

33618 (AEC-tr-7303, pp 99-104) ELUCIDATION OF THE ROLE OF RADIOTOXINS IN RADIATION MUTAGENESIS. Kuzin, A. M.; Veksler, A. M.; Yurov, S. S.; Kopylov, V. A. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 11: No. 3, 392-5(May-Jun 1971).

The irradiation of bacteria Escherichia coli B inhibits their phage-producing ability and leads to the formation of r-mutants of the phage T4Br$^+$, showing a dependence both on the dose of irradiation of the bacteria and on the conditions of irradiation and subsequent storage. The isolated radiotoxins limit the action of ionizing radiation on bacterial cells, which is manifested in a decrease in the ability of the bacteria to produce T4 phage and in the formation of r-mutants of the phage. The model radiotoxin DOPA partially simulates the action of γ radiation: it induces an increased yield of r-mutants of the phage but does not influence the phage-producing ability of the bacteria. (tr-auth)

33619 (AEC-tr-7303, pp 112-18) RELATIONSHIP BETWEEN POSTRADIATION RECOVERY IN WATER AND MODIFICATION OF THE SURVIVAL OF IRRADIATED YEAST CELLS ON VARIOUS NUTRIENT MEDIA. Kapul'tsevich, Yu. G.; Kabakova, N. M. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 3, 401-5(May-Jun 1971).

The postradiation modification of survival on nutrient media with various wort contents was investigated in six strains of polyploid yeast, which regained viability to various degrees when kept in water after irradiation. It was shown that in five strains of yeast, a high degree of recovery in water is accompanied by great modification of the survival of the irradiated cells on various nutrient media, while a low degree of recovery is accompanied by slight modification. In one of the investigated yeast strains, substantial modification of the survival of the cells on various nutrient media and relatively low postradiation recovery in water can be observed; moreover, on minimum nutrient medium the survival of the cells immediately after irradiation exceeds the survival on standard nutrient medium both immediately after irradiation and after maximum recovery in water. It was concluded that this modification of survival is not always due only to postradiation recovery. (tr-auth)

33620 (AEC-tr-7303, pp 119-28) INFLUENCE OF POSTRADIATION RECOVERY ON THE SHAPE OF THE SURVIVAL CURVE OF YEAST CELLS. Kapul'tsevich, Yu. G. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 3, 406-12(May-Jun 1971).

The results of calculations of the exponential, multihit, and multitarget survival curves are presented, considering postradiation recovery of cells during growth on nutrient medium. Since the realization of potential damages in yeast cells irradiated at the same dose does not occur simultaneously, postradiation recovery may change the shape of the survival curves. In the presence of sufficiently intensified recovery, the extrapolation number may be reduced, while in "convex," that is, similar to multihit survival curves, an exponential portion may appear. (tr-auth)

33621 (AEC-tr-7303, pp 197-200) STUDY OF THE INFLUENCE OF IONIZING RADIATION ON THE IONIC PERMEABILITY OF CELLS OF THE BACTERIA STAPHYLOCOCCUS AUREUS STRAIN 1623 AND ESCHERICHIA COLI STRAIN 1126 AND THE YEAST SACCHAROMYCES ELLIPSOIDEUS. Kononenko, K. I.; Chaykina, L. A. (Kharkov State Univ.). Translated from Radiobiologiya; 11: No. 3, 461-3(May-Jun 1971).

The ionic permeability of γ-irradiated bacterial and yeast cells was investigated. It was shown that the increase in the cationic permeability of the irradiated cells is associated with a disturbance of the distribution of charges on the surface of the cell. Metal ions restore the normal cationic permeability. The increase in anionic permeability is associated with structural changes in the cell surface. (tr-auth)

33622 (AEC-tr-7303, pp 216-18) VARIATION OF THE SURVIVAL OF CHLORELLA AS A FUNCTION OF THE DENSITY OF THE IRRADIATED SUSPENSION. Sakovich, I. S.; Ovchinnikova, O. F. Translated from Radiobiologiya; 11: No. 3, 472-3(May-Jun 1971).

With increasing density of the cell suspension in the irradiation of Chlorella by γ rays, a decrease in the survival of the cells is observed. (tr-auth)

33623 (COO-3419-3) CHARACTERIZATION OF GENETIC CODING CHANGES IN BACTERIA PRODUCED BY THE RADIOACTIVE DECAY OF INCORPORATED ^{3}H- AND ^{14}C-LABELED COMPOUNDS. Person, Stanley; Phillips, Stephen L.; Andersen, F. Alan; Newton, Helen P. (Pennsylvania State Univ., University Park. Dept. of Biophysics). [1970]. 11p. (CONF-700610-16). Dep. NTIS.

From fourth international congress of radiation research; Evian, France (29 Jun 1970).

Cultures of Escherichia coli were treated with ^{3}H-methyl thymidine, ^{3}H-6-uracil, ^{3}H-histidine and gamma radiation. The tabulated results show the net number and percentage distributions into classes for E. coli arginine revertant mutations induced by the various mutagens. A discussion is presented of the mechanisms of genetic coding changes and it was concluded that the mechanisms by which the tritium-labeled compounds produce mutations are by beta particle ionizations. (H.L.W.)

33624 OBSERVATIONS ON STARVATION-INDUCED RESISTANCE ENHANCEMENT (SIRE) IN SALMONELLA TYPHIMURIUM. Rowbury, R. J. (University Coll., London). Int. J. Radiat. Biol.; 21: No. 3, 297-302(Mar 1972).

The resistance to uv radiation of strain 11G of Salmonella typhimurium was studied over a dose range 0 to 1250 ergs/mm^2. This strain fails to initiate a new round of DNA replication at 38°C, incubation at this temperature giving rise to cells with completed chromosomes, but with growth and protein synthesis taking place relatively normally. Cell division and viability were unaffected for $\sim$75 min. Cells incubated at 25°C for 225 min showed an enhanced resistance when starved of tryptophan, isoleucine and valine, the dose-response curves being similar to those of Escherichia coli, and at high doses to those of 11G exponentially growing cells. Incubation in the presence of the amino acids at 38°C for short periods gave a small increase in resistance, most marked after 25 or 35 min; after 45 min the resistance was almost the same as that of the exponential 25°C culture, and then dropped sharply. With incubations longer than 45 min at 38°C, cells showed marked sensitivity, prevented by withholding the amino acids. The resistance was enhanced to the same degree as for cells starved at 25°C, and could be abolished by nalidixic acid (15 μg/ml), an inhibitor of DNA synthesis, the sensitivity becoming the same as that of the exponential 25°C cultures. Replacing amino acids after 65 min of starvation at 38°C led to increased uv sensitivity. (UK)

33625 RNA-SYNTHESIS IN IRRADIATED DIPLOID YEAST AT 50 PER CENT SURVIVAL LEVEL. Koch, Herbert; Kiefer, Juergen (Justus Liebig Univ., Giessen, Ger.). Int. J. Radiat. Biol.; 21: No. 3, 223-34(Mar 1972).

Diploid yeast Saccharomyces cerevisiae was irradiated with uv, x-rays or α-particles to yield a colony-forming ability of about 50%. RNA-synthesis per cell after irradiation was measured. After uv and x-rays, it was increased for RNA with sedimentation constants of 26s, 17s and <5s. The increase for <5s RNA was higher than for the other types measured. Photoreactivation after uv-exposure led to an even higher increase. Alpha irradiation resulted in a decrease of RNA-synthesis per cell; the reduction was the same for 26s-, 17s- and <5s-RNA. (UK)

33626 INFLUENCE OF BACTERIA AND THEIR EXTRACT ON TREATED CELLS. Mukherjee, P. (Saha Inst. of Nuclear Physics, Calcutta). Stud. Biophys.; 28: No. 1, 35-41(1971).

X-irradiated Escherichia coli B cells are found amenable to restoration by treatment with unirradiated bacteria or cell-free extract. This restoration phenomenon was not observed with BUdR and 32p treated bacteria. The cause of this absence is not known. (auth)

33627 CONTROL OF SCLEROTIUM ROLFSII SACC. ASSOCIATED WITH DAMPING-OFF DISEASE OF SEEDLINGS BY FUNGICIDAL TREATMENT AND BY IRRADIATION. Khawthephavan, Phithoon; Celino, Martin S. (Araneta Univ., Malabon, Philippines). Araneta J. Agr.; 18: No. 1, 32-62(Jan-Mar 1971).

The results obtained in the present study are briefly summarized. Treatment with the fungicides, Orthocide, Agallol and Antracol indicated strong repressive effect on the growth of the soil-borne plant pathogen, Sclerotium rolfsii Sacc. The percentage germination of the indicator lettuce seeds in the Orthocide treated S. rolfsii Sacc.-infested soil ranged from 23.88 to 71.13; in the Agallol treated parasite-infested soil, 20.50 to 26.24 percent, compared with 6.2 to 17.8 percent seed germination in the control. Orthocide and Agallol treatments produced similar and more repressive effects than Antracol against Sclerotium rolfsii Sacc. as shown by the percentage germination of the indicator lettuce seeds. The inhibitive effect of the fungicides on the growth of Sclerotium rolfsii Sacc. was shown also in Petri dish cultures. The sclerotial bodies of the fungus failed to germinate in the Agallol and in the Orthocide-treated agar culture media. The Antracol treatment, however, did not present the germination of the sclerotial bodies on the agar culture medium but the growth of the mycelium was much retarded compared with that of the control. Radiation treatment of mature sclerotial bodies of Sclerotium rolfsii carried in soil medium and exposed at a radiation dose of as high as 3,328 Kr. for 64 hours, and those sclerotial bodies carried in agar culture media exposed at a radiation dose of as high as 120 Kr. for 24 hours, were not destroyed after the treatment, as shown by their subsequent germination and growth on potato dextrose agar culture medium in Petri dish. (auth)

33628 CELL DEATH AND ITS MODIFICATION: THE ROLES OF PRIMARY LESIONS IN MEMBRANES AND DNA. Alper, Tikvah (Hammersmith Hospital, London). pp 171-84 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Mainly from work with bacteria, it has been inferred that reproductive death may follow the absorption of ionizing radiation in one of at least two important targets, namely the DNA (type N damage), and the prokaryotic cell membrane, or eukaryotic nuclear membrane (type-O damage). The importance of the bacterial or nuclear membrane may well arise from its role as the site of attachment and origin of replication of DNA. The modifying action of agents present during irradiation, or of growth conditions before or after, is usually unequal for these two main targets. For example, lethal damage consequent on the deposition of energy in nucleic acid is only slightly, if at all, enhanced by the presence of oxygen, whereas the oxygen enhancement ratio for membrane damage can be extremely high. Culture conditions appear to enhance or inhibit repair mainly of damage to DNA, or mainly of type O or membrane damage. Radiation quality or LET is an important modifier of damage. With bacteria, the maximum value of RBE is about 1.6, but this represents a true dose-modifying factor, i.e., there is no change in the nature of dose-effect relationships. From various lines of evidence, it may be inferred that the RBE effect is attributable to type O or membrane damage (but possibly to an increase in effectiveness of interaction between nucleic acid and membrane damage). With prokaryotic cells, RBE values are higher: but these are, to a large extent, due to a diminution in the extent of sub-lethal damage, as LET increases. The change in the average energy required per lethal event is hardly more with mammalian than with bacterial cells. It is possible, therefore, that RBE effects with mammalian cells may be attributable to energy absorption both in DNA (change in extent of sub-lethal damage) and in the nuclear membrane or membrane-chromatin complex. (auth)

33629 GAMMA IRRADIATION OF E. COLI RIBOSOMES. Reinecke, C. J. (Univ. of Potchefstroom, S. Afr.). pp 207-16 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Ribosomes of E. coli were irradiated at 2°C with γ rays from a 1100-Ci ^{60}Co-source at a dose-rate of 4.5×10^4 rad/h. The effect of the irradiation of the ribosomes on polypeptide synthesis was studied in a cell-free system, using poly U as messenger. Kinetic experiments showed that the amount of polyphenylalanine synthesized was decreased by the irradiation of the ribosomes. This was noticed at all times of incubation. The maximum amount of acid precipitable material was formed after 10 min, whereafter a diminution in the amount of this material occurred, owing to proteolytic activity of the ribosomes. The latter activity became less pronounced if the synthesis was performed in the presence of irradiated ribosomes, indicating that not only reactions implicated in the synthesis, but also reactions associated with the degradation of the polypeptides are inactivated by the irradiation. The inactivation of the ribosomes was also noticed if the synthesis was performed at different magnesium and ribosome concentrations. Sucrose gradient centrifugation and membrane filter filtration revealed that the binding of poly U to the ribosomes is also sensitive to the irradiation. This was observed with 30S as well as 70S ribosomes. The percentage inactivation of the binding of poly U to the ribosomes was less than the percentage inactivation of of the synthesis. These results suggest that the inactivation of the ribosomes by the irradiation does not appear to be due to the inactivation of one single reaction associated with the ribosomes, but to at least a number of reactions wherein the ribosomes participate during protein synthesis. (auth)

33630 ROLE OF SHORT-LIVED TRANSIENTS IN RADIOSENSITIZATION OF BACTERIAL CELLS BY CHEMICALS. Gopal-Ayengar, A. R.; Shenoy, M. A.; Singh, B. B. (Bhabha Atomic Research Centre, Trombay, India). pp 449-505 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB—286; CONF-710314.

The enhancement of radiation lethality of E. coli B/r cells by iodine compounds and quinone derivatives could be ascribed to short-lived transients of the sensitizers formed owing to their reaction with hydroxyl radicals. N-ethyl maleimide (NEM) as well as isatin and ninhydrin also sensitized E. coli cells to γ-rays via short-lived transients, but such species were shown to be formed by the reaction of electrons. Consequently, scavenging of OH radicals with KCNS proved ineffective whereas scavenging of electrons with $NaNO_3$ reduced the sensitizing ability of these compounds. In certain cases, however, an enhancement in the sensitization was noticed on scavenging electrons with N_2O, which indicated an efficient electron transfer to the sensitizer by the scavenger. Using ^{14}C NEM, increasing amounts of radioactivity were detected in bacterial proteins on irradiation under anoxia when sensitization was also observed. On irradiation in presence of air, however, sensitization could not be observed and a very small amount of radioactivity was detected in the cells. Post-irradiation synthesis of proteins and DNA and degradation of DNA were the other major effects studied. (auth)

33631 ESR STUDIES ON SHORT-LIVED TRANSIENTS OF RADIOSENSITIZERS. Singh, B. B.; Verma, N. C.; Gopal-Ayengar, A. R. (Bhabha Atomic Research Centre, Trombay, India). pp 507-16 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB—286; CONF-710314.

Short-lived transients have been shown to play an important role in radiosensitization of bacterial cells by chemicals. Such transient species are believed to be produced in the extracellular medium as a consequence of water radiolysis. The nature of some of these transients has been investigated using the technique of electron spin resonance (ESR) spectroscopy. The species formed by the reaction of radiation-induced electrons and hydrogen atoms could be studied by irradiating frozen alkaline and acidic solutions of the sensitizers. The hydroxyl radicals, produced during ultraviolet photolysis of sensitizer-H_2O_2 system, were also found to react at 77°K and they gave rise to the sensitizer radicals. Iodoacetic acid, a well-known radiosensitizer, showed high reactivity towards electrons exhibiting ESR signal from CH_2COONa radicals but the radiosensitizing transients were suggested to be the iodine atoms formed by reaction of OH radicals. Evidence was also found for the reaction of N-ethyl maleimide (NEM) with electrons which is believed to cause the sensitization of cells. Radicals, formed by H/OH addition at the carbon—carbon double bond of NEM, were also observed. The reaction of other sensitizers with e, H and OH will be discussed. (auth)

33632 MODIFICATION OF BACTERIAL SENSITIVITY TO RADIATION BY TREATMENT WITH A KETO-ALDEHYDE. Alcantara Gomes, R.; Pinheiro, R. S. A.; Leitao, A. C.; Caldas, L. R. (Univ. Federal, Rio de Janeiro. Comision Nacional de Energia Nuclear, Rio de Janeiro). pp 517-24 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB—286; CONF-710314.

A keto-aldehyde, reductone, produced an intense lethal effect in ultraviolet-irradiated bacteria; various evidence is described suggesting that reductone blocks the enzymatic repair process. The importance of radiation quality in the sensitization of E. coli to the reductone effect was studied. It is shown that several wavelengths, in the 237 to 300-nm range, are able to sensitize; this does not occur when bacteria are irradiated with near uv, visible light, and γ rays; this last point has been verified under both direct and indirect effect conditions. The action mechanism of reductone was studied and the intensity of the lethal effect of this substance in uv-irradiated bacteria grown in the presence of an analogue of thymine (5 bromo-uracil) was measured. The uptake of this analogue by the DNA makes bacteria resistant to reductone and sensitive to radiation; this finding also suggests that reductone acts at the repair level. A comparative study of reductone and caffeine, a substance which seems to block repair, was carried out. Several bacteria and bacteriophage strains were studied and the results allow a discussion of the probable action of reductone at the molecular level. Two different hypotheses are considered: the reductone blocks the repair by a direct effect on the enzymes; the reductone is combined with DNA photoproducts (perhaps the thymine dimers) and this prevents the interaction of the enzymes with this modified substract. (auth)

33633 NEW RADIATION SENSITIVE MUTANT OF ESCHERICHIA COLI K-12. Storm, P. K.; Zaunbrecher, W. M. (State Univ., Utrecht). Mol. Gen. Genet.; 115: No. 1, 89-92 (1972).

A radiation sensitive mutant of E. coli K-12 was isolated. It has properties in common with several Uvr mutants (Table 2) and therefore it is proposed to denote this mutant as uvrF. (auth)

33634 EFFECT OF ACRIFLAVINE ON THE RADIATION RESISTANCE ENHANCEMENT INDUCED BY CYSTEINE TREATMENT IN ESCHERICHIA COLI B/r. Hernadi, F.; Kari, Cs. (Univ., Debrecen, Hungary). Experientia; 28: No. 2, 155-6 (15 Feb 1972).

Cultures of Escherichia coli B/r were treated with cysteine and x-irradiated. Surviving fractions were plated on nutrient agar and on agar containing acriflavine, an inhibitor of DNA repair. It was found that the radiation resistance induced by cysteine was not affected by acriflavine. Results indicated that the enhancement of radiation resistance induced by cysteine resulted from decreasing the intrinsic sensitivity of cells to damaging effects of irradiation or from increasing the recovery after irradiation. (H.L.W.)

33635 RADIOSENSITIZATION OF BACTERIAL SPORES BY KETONIC AGENTS OF DIFFERING ELECTRON-AFFINITIES. Tallentire, A.; Jacobs, G. P. (Univ. of Manchester, Eng.). Int. J. Radiat. Biol.; 21: No. 3, 205-13(Mar 1972).

Three ketonic agents, acetone, acetophenone and p-nitroacetophenone, sensitized spores of Bacillus megaterium in anoxic buffer suspension (pH 7.0) to the lethal effects of gamma-rays. For all of three agents, increases in concentration caused increases in the extent of sensitization to a common maximal level and, for acetone and p-nitroacetophenone, increases beyond that responsible for the maximal effect gave decreases in sensitization. The maximal increase represented about 40 percent of the oxygen effect. The sensitizing actions of agents and oxygen were not additive. A correlation between the effectiveness of agents as sensitizers on a molar basis and their relative electron-affinities was seen, substantiating the proposal that the radiation-induced electron is involved in radiosensitization by ketonic agents. (UK)

33636 LON-LIKE MUTANTS OF PLAGUE BACTERIA. Martinevskii, I. L. (Middle Asian Antiplague Inst., Alma-Ata, USSR). Genetika; 8: No. 2, 145-8(Feb 1972). (In Russian).

Lon$^-$-like mutants of plague bacteria (Pasteurella pestis) are described. The mutants are incapable of growth after uv-irradiation; they are sensitive to low doses of uv-light and deficient in photoreactivation and dark reparation. They form large colonies on minimal medium and are avirulent for guinea pigs and albino mice. (auth)

33637 CONDITIONAL LETHAL RADIOSENSITIVE YEAST MUTANTS. I. ISOLATION OF MUTANTS AND THEIR GENETICAL AND RADIOBIOLOGICAL CHARACTERISTICS. Bandas, E. L.; Zakharov, I. A. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika; 8: No. 2, 101-8(Feb 1972). (In Russian).

Four mutants sensitive to x-irradiation and elevated temperature were induced by uv-light in yeast Saccharomyces paradoxus. The mutations responsible for such a sensitivity were found to be non-allelic and were designated as txs$_1$, txs$_2$, txs$_4$ and txs$_5$. These mutants exhibited the increased sensitivity not only to x-rays but to uv-light also. The mutants did not grow under the temperature 37°C unlike the control strain. The capacity of the mutant strains for mitotic recombination induced by x- and uv-irradiation was decreased in comparison with the control strain. (auth)

33638 WATER-DERIVED RADICALS AND RADIATION SENSITIVITY OF BACTERIOPHAGE T7. Powers, E. L.; Gampel-Jobbagy, Zulema (Univ. of Texas, Austin). Int. J. Radiat. Biol.; 21: No. 4, 353-9(Apr 1972).

The coliphage T7 was x-irradiated in the presence and absence of ethanol, an effective ·OH and ·H scavenger, in buffered suspensions saturated with N$_2$, N$_2$O, and O$_2$. In 10^{-3} × dilution of the original suspending organic medium, ethanol was protective in all three experimental conditions. In 10^{-5} × dilution of the original medium (equivalent to contaminant free), ethanol is also protective in all three experiments and to a greater extent; but the relative order of radiation sensitivities changes. It is concluded that, when irradiated in pure suspension, T7 phage is inactivated partly by ·OH, and that ·H and e_{aq}^- play small, if any, roles as inactivating species. Additional observations were that the "O$_2$-protection" phenomenon absent in purified suspension is observed in 10^{-3} M ethanol solutions; and that there is evidence that exhaustion of additives and, perhaps, build-up of products are responsible for the biphasic natures of some response lines. Also, there is evidence that radiation-induced sub-lethal damage to the phage particles may be important in determining sensitivity. (auth)

33639 FUNCTIONAL INACTIVATION AND APPEARANCE OF BREAKS IN RNA CHAINS CAUSED BY GAMMA IRRADIATION OF ESCHERICHIA COLI RIBOSOMES. Kucan, Zeljko; Kerak, Janko N.; Pecevsky-Kucan, Ira (Inst. Rudjer Boskovic, Zagreb). Biophys. J.; 11: No. 3, 237-51(Mar 1971).

70S ribosomes and 30S ribosomal subunits from Escherichia coli MRE 600 were exposed to gamma irradiation at –80°C. Exponential decline of activity with dose was observed when the ability of ribosomes to support the synthesis of polyphenylalanine was assayed. Irradiated ribosomes showed also an increased thermal lability. D$_{37}$ values of 2.2 MR and 4.8 MR, corresponding to radiation-sensitive molecular weights of 3.1×10^5 and 1.4×10^5, were determined for inactivation of 70S ribosomes and 30S subunits, respectively. Zone sedimentation analysis of RNA isolated from irradiated bacteria or 30S ribosomal subunits showed that at average one chain scission occurs per four hits into ribosomal RNA. From these results it was concluded that the integrity of only a part of ribosomal proteins (the sum of their molecular weights not exceeding 1.4×10^5) could be essential for the function of the 30S subunit in the polymerization of phenylalanine. This amount is smaller if the breaks in the RNA chain inactivate the ribosome. (auth)

33640 EFFECT OF X-RAYS ON THE MYCETOMA OF ICERYA PURCHASI MASK (HOMOPTERA, COCCOIDEA, MONOPHLEBINAE). Echaubard, Michel (Institut National Agronomique, Paris). Compt. Rend., Ser. D; 274: No. 5, 701-4 (31 Jan 1972). (In French).

The symbionts contained in the mycetoma of Icerya purchasi Mask occur in two forms: a vegetative form existing in the various pupal stages and in adult females; an infectious form, observed only in adult females, thus assuring transmittance to the descendants by means of the oocyte. Irradiation of the pupas causes the appearance of advanced transmission forms. The effect is most apparent with small doses. Various hypotheses are put forward to explain the action of the x rays. (France)

33641 LACTOBACILLUS EXONUCLEASE MUTANTS. II. SENSITIVITY TOWARD ULTRAVIOLET IRRADIATION AND ALKYLATING AGENTS. Nozawa, Ryushi; Gabor, Magda; Hotchkiss, Rollin D. (Rockefeller Univ., New York). J. Mol. Biol.; 65: No. 2, 323-30(28 Mar 1972).

Mutants of Lactobacillus acidophilus R-26, an organism that requires a source of deoxyribonucleoside for its growth, were selected for inability to grow in a basal medium supplemented with nitrophenyl esters of thymidine 3′- or 5′-monophosphates. These esters are specific substrates in vitro for exonucleases of the bacterium. Among the selected strains were found exonuclease-altered mutants, whose extracts failed to hydrolyze normally the 3′- or 5′-nitrophenyl diesters, respectively (Hotchkiss, Nozawa & Gabor, 1971). It was found that 5′-exonuclease mutants are sensitive to uv irradiation, nitrosoguanidine, and methyl methanesulfonate treatment. Spontaneous and nitrosoguanidine-induced mutability of these mutants was lower than that of the wild strain, indicating that the 5′-exonuclease function may be involved in the DNA repair system. By contrast, 3′-exonuclease mutants did not exhibit such sensitivity. (auth)

33642 MUTAGENIC EFFECTS OF THYMINE DIMERS IN BACTERIOPHAGE T4. Meistrich, Marvin L. (Bell Telephone Labs. Inc., Murray Hill, N. J.); Drake, John W. J. Mol. Biol.; 66: No. 1, 107-14(28 Apr 1972).

Sensitized irradiation of bacteriophage T4v, which forms, almost exclusively, thymine dimers in the phage DNA, produces 2.4×10^{-4} r mutants per lethal hit. Nearly all of the mutations can be reversed by photoreactivation. The rII mutants produced by sensitized irradiation are primarily frameshift mutants and G·C → A·T transitions. Thymine dimers must be premutational lesions for both types of mutations. These results are inconsistent with models for ultraviolet mutagenesis involving base changes opposite the photochemical lesions but do support more indirect mechanisms. (auth) (UK)

33643 MULTIPLE MUTANTS OF SACCHAROMYCES CEREVISIAE. I. ORIGIN AND GENERAL CHARACTERISTICS. Chitavichyus, D. B.; Inge-Vechtomov, S. G. (Leningrad State Univ.). Genetika; 8: No. 1, 95-101(Jan 1972). (In Russian).

Polyauxotrophic haploids of Peterhof yeast collection of Saccharomyces cerevisiae were treated with uv light (3000 and 4500 erg/mm^2). Twenty-two multiple mutant clones were discovered among the survivors. The multiple mutants bear reversions at three different genes. Majority of them had forward mutation at leu$_2$. In some of them, their mating type changed and/or their chromosome number doubled. The origin of the multiple mutants can be explained as an expression of mutation toward genetic instability under the influence of uv light. The possibility of the stepwise origin of the multiple mutants during divisions of the mutagenized cells is under discussion. (auth)

33644 COMPARATIVE EFFECT OF N-METHYL-N′-NITRO-N-NITROSOGUANIDINE AND UV LIGHT ON FUSARIUM MONILIFORME, THE PRODUCER OF GIBBERELLIN. Erokhina, L. I.; Efremov, B. D.; Mikhlina, L. L. (Inst. of Genetics of Microorganisms, Moscow). Genetika; 8: No. 1, 168-71(Jan 1972). (In Russian).

A comparative study of induced variability of a number of biochemical mutants with different nutritional requirements and of two prototrophic strains of Fusarium moniliforme was performed. Mutants and prototrophs were treated with mutagenic factors of alternative nature, N-methyl-N′-nitro-N′-nitrosoguanidine, and uv light. High mutagenic activity of nitrosoguanidine was shown in comparison with uv light. It was found that mutants displayed different mutability for the frequency of arising of prototrophic revertants and morphologically aberrant variants. The highest frequency of induced prototrophic revertants was observed in nicotinic acid requiring mutant, the lowest—in adenine requiring mutant. (auth)

Radiation Effects on Plants (External Source)

Refer also to abstracts 33614, 33703, 33743, and 33744.

33645 (AEC-tr-7303, pp 140-6) RADIOSENSITIVITY OF SEA BUCKTHORN SEEDS. Privalov, G. F.; Shmeleva, Yu. F. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Translated from Radiobiologiya; 11: No. 3, 421-5(May-Jun 1971).

The irradiation of sea buckthorn seeds with γ rays at a dose of 60 kR leads to a 50% decrease in the germination of the seeds when planting in a hothouse in vermiculite and a 50% decrease in survival of the plants after they have overwintered under field conditions. Stimulation of germination of the seeds in the field and stimulation of growth of the plants in height occurred after irradiation at doses of 1 to 20 kR. Irradiation of the seeds with fast neutrons at doses between 1 and 2 krad produced a 50% reduction of the germination rate. (tr-auth)

33646 (AEC-tr-7303, pp 147-53) EFFECTS OF γ AND ELECTRON RADIATIONS ON POTATOES. Serebrenikov, V. S.; Anisimov, B. V.; Parfenov, V. T.; Lipsits, D. V. (Scientific Research Inst. of Potato Raising, Moskovskaya Oblast, USSR). Translated from Radiobiologiya; 11: No. 3, 426-30(May-Jun 1971).

A study of the influence of γ and electron radiation on potato tubers shows that the response of plants to irradiation is identical. However, with both types of irradiation, phenomena of stimulation and inhibition are observed at different doses. It is hypothesized that the different biological effectivenesses of the radiations depend on the distribution of the ions in space and the ionization density. Under the influence of electrons on the tubers, only a local effect is observed. (tr-auth)

33647 (AEC-tr-7303, pp 201-5) CHANGE IN THE RATIO OF SEX TYPES OF DICOT AND MONOCOT HEMP UNDER THE INFLUENCE OF PREPLANTING γ IRRADIATION. Kovalenko, V. M.; Zhatov, A. I. (All-Union Scientific Research Inst. of Bast Crops, Glukhov, USSR). Translated from Radiobiologiya; 11: No. 3, 463-6(May-Jun 1971).

Investigations conducted under field conditions established that preplanting γ irradiation of hemp seeds produces a decrease in the survival of male plants of dicot hemp and heterozygous plants of monocot hemp. (tr-auth)

33648 (AEC-tr-7303, pp 211-15) INVESTIGATION OF THE RADIOSENSITIVITY OF THE POTATO IN VARIOUS PERIODS OF ONTOGENESIS. Serebrenikov, V. S.; Krupnova, L. V. (Scientific Research Inst. of Potato Raising, Moskovskaya Oblast, USSR). Translated from Radiobiologiya; 11: No. 3, 469-71(May-Jun 1971).

The influence of γ irradiation in doses of 100 and 300 rad, 3, 10, and 30 krad on potato plants of the Lorkh variety in the period of budding and blooming was studied. It was shown that in plants irradiated at doses of 10 and 30 krad, there is no tuber formation, which is evidently associated with a disturbance of the outflux of plastic substances. When the potatoes were irradiated in the phase of blooming, tuber formation in the plants was suppressed to a lesser degree. (tr-auth)

33649 (ANL-7870) DIVISION OF BIOLOGICAL AND MEDICAL RESEARCH ANNUAL REPORT, 1971. (Argonne National Lab., Ill.). Dec 1971. Contract W-31-109-eng-38. 168p. Dep. NTIS.

Neutron and gamma-ray toxicity studies included dosimetry studies for the JANUS program, development of computer programs for long-term studies, RBE of neutrons from the JANUS reactor, and effects of ionizing radiation on chickens and mice. Research on carcinogenesis was concerned with in vitro and in vivo studies on factors influencing chemically induced tumors and mechanisms involved in enhancement of tumor incidence, control of enzyme production, and development of test systems. Studies on aging included cellular and immunological mechanisms of aging, comparative biology of aging in rodents, genetics of aging in mice, aging of insects in relation to biosynthesis, and mathematical models of aging and radioinduced life shortening. Progress is also reported in the fields of biochemistry, biophysics, genetics, toxicity and metabolism of radionuclides, and laboratory animal facilities. (H.L.W.)

33650 MUTATIONAL EFFICIENCY OF FAST NEUTRONS IN LENS ESCULENTA (MOENCH). Uhlik, Jan (Agricultural Univ., Prague). Genet. Slechteni; 8: No. 1, 21-8(Jan 1972). (In Czech).

The paper gives first findings concerning mutational efficiency of fast neutrons in lentil. Irradiation at the highest dose of neutrons (designated dose 14) induced the highest rate of segregating offsprings that comprised chlorophyll mutations and chimeric plants (25.3%). The second maximum of mutational efficiency (23.8% of the offsprings) appeared when the dose 4 was employed. Offsprings segregating out simultaneously two or more kinds of chlorophyll mutants were recorded at the frequency from 1.2 to 6.6%, respectively. Most different kinds of mutants and combinations of two or three different mutants appeared in offsprings where the dose 5 was employed. Various combinations of different mutants that segregated out in the same offspring were induced mostly by the dose 8. The highest number of chlorophyll mutants per one offspring was 0.40 mutant. The highest number of mutants per 100 seed in M_1 generation amounted to 3.44 mutants. The radiation from the Czechoslovak cyclotron, whose fundamental component was represented by fast neutrons, may be employed for the purposes of mutational breeding program. The determination of the dose in rad presents some difficulties. The dose may be expressed as follows: performance of cyclotron (13 MeV); distance of seeds which were spread in even distances from the beryllium disk that was irradiated by deutrons (20 cm to 63.2 cm); period of irradiation (1 hour). (auth)

33651 VARIABILITY OF THE QUANTITATIVE CHARACTER IN MAIZE AFTER CHRONIC IRRADIATION OF F_1 HYBRID GENERATION. Cerny, Jiri; Stehno, Zdenek (Agricultural Univ., Prague). Genet. Slechteni; 8: No. 1, 37-46(Jan 1972). (In Czech).

The F_1 hybrid generation of maize was irradiated chronically by gamma rays at the dose from 1969 R/veget. to 175 R/veget. The intensity of radiation varied from 0.714 R/hr to 0.063 R/hr. The effect of these doses on expanding the variability of some quantitative characters in segregating the F_3 hybrid generation was examined. Chronic irradiation of plants in F_1 generation expanded both the phenotypical and genotypical variability of the following characters in F_3 hybrid population: number of leaves per plant, length of plants, thousand-kernel weight, and length of heads. In most characters studied, maximal expanding of variability was observed when doses from 1969 R/veget. to 902 R/veget. were applied. Chronic irradiation of hybrid plants in generation F_1 led to a shift of average values in quantitative characters of generation F_3. This shift had an opposite direction in comparison with the selection in previous generation. The influenced F_3 populations comprised classes with both lower and higher values of characters in comparison with the control non-influenced F_3 population. This makes it possible to achieve a higher response to the selection in quantitative characters. (auth)

33652 CHANGES IN SOME PHYSIOLOGICAL AND BIOCHEMICAL PROCESSES IN GAMMA IRRADIATED PLANTS. Sergeeva, E. A. Sb. Tr. Agron. Fiz.; No. 24, 181-4(1969). (In Russian).

The effect of gamma rays on changes in the content of growth regulators in Perilla (mint) leaves was studied, and the distribution of labeled metabolites among the plant organs was noted in relation to growth disturbance during the post-irradiation period. The contents of auxins and growth inhibitors in upper and lower leaves were determined by paper chromatography. Labeling was accomplished by exposure of a pair of upper leaves to $^{14}CO_2$ for 10 min. Irradiation with gamma radiation was performed with 3, 6, and 8 kR doses. In radiation slowed plant growth, growth-activating substances (auxins) decreased in content, but growth inhibitor content increased. (K.S.W.)

33653 RADIOBIOLOGICAL EFFECTS OF GAMETOPHYTE IRRADIATION IN BARLEY AND DURUM WHEAT. Devreux, M.; Donini, B. (CNEN, Rome). Radiat. Bot.; 12: No. 1, 19-29(Feb 1972). (In French).

Spikes of barley and durum wheat were acutely irradiated in the Casaccia field (^{60}Co source) at different developmental stages of their gametophytes. M_1 plants were raised following irradiation of male gametophytes, female gametophytes and both male and female gametophytes. The total exposure was 1500 R, 93 R/hr in all cases, while only on both gametophytes for durum wheat, four total exposures were used (750, 1500, 2250 and 3000 R). The radiobiological parameters considered were: M_0 spike fertility, M_1 seed germinability, M_1 seedling and plant abnormality and M_1 spike fertility. The results show that: the female gametophyte is more radioresistant than the male one; the gametophyte radiosensitivity of the two species is very similar; the tetrapoloidy of the durum wheat allows many altered plants to go through the following generation, moreover these plants show a reduced fertility; in barley, altered genotypes are more precociously eliminated; the developmental stage of the male gametophyte is determinant of the radiosensitivity, even when both gametophytes are irradiated together; the radiosensitivity strongly decreases with progressive gametophyte development; several chromosome aberrations are induced by this type of treatment; those induced during the mononucleate stage very rarely reach the fertilization while those induced during the bi- and trinucleate stages can persist in the successive generation. This is due to the absence of an efficient haplontic selection among the gametes and to the absence of any competition after fertilization, being only one cell: the zygote. (auth) (UK)

33654 INFLUENCE OF VEGETATIVE PLANT IRRADIATION ON MICROSPOROGENESIS IN DIPLOID AND TETRAPLOID COTTON SPECIES. Ibragimov, Sh. I.; Alimukhamedov, A. A. (Inst. of Cotton Agriculture, Tashkent). Tsitol. Genet.; 5: No. 6, 500-4(Nov-Dec 1971). (In Russian).

Diploid and tetraploid cotton plants in the budding stage were irradiated from a ^{60}Co source at 19 R/sec to produce integral doses of 1,000, 2,000 and 3,000 R. A study of the anomalies in microsporogenesis showed that the number of anomalies depended on the size of the dose and the plant species; however, different doses of radiation produced the same type of anomaly in any one species. It was found that diploid species were more radiosensitive than tetraploid species. (H.L.W.)

33655 VARIABILITY IN THE CHEMICAL COMPOSITION OF HIPPOPHAE RHAMNOIDES L. FOLLOWING IONIZING RADIATION OF SEEDS IN STIMULATING DOSES. Privalov, G. F.; Solonenko, L. P.; Trofimova, O. S. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 10, Ser. Biol. Nauk; No. 2, 72-6(Aug 1971). (In Russian).

The variability in oil content in fruits and seeds, sugar content, total acidity of fruit juice, and weight of fruits was studied in different normal trees and in trees produced following γ irradiation in doses of 1 to 20 kR. The average oil content in the fruits studied (without seeds) in different years ranged from 2.8% to 5.9% and in individual trees the range was within 1.2% to 9.6%. Sugar content in the fruits ranged from 1.4% to 10.9%; the average weight of 100 fruits was 24.4 g. to 37.6 g. with variations in different trees from 16.7 g. to 54.9 g. It was established that the irradiation before sowing of seeds by γ rays in doses stimulating the growth of plants in height does not result in considerable change of oil and sugar content in the fruits, but somewhat increases total acidity and decreases the average weight of fruits or does not change at all. No correlation between the level of oil content and water soluble sugar in fruits was found. (auth)

33656 RESPONSE OF THE ALGA CHLORELLA SOROKINIANA TO ^{60}Co GAMMA RADIATION. Kunz, W. F. (Grumman Aerospace Corp., Bethpage, N. Y.). Nature (London); 236: No. 5343, 178-9(24 Mar 1972).

This unicellular green alga has been considered for the bioregeneration of O_2 from waste CO_2 in closed ecological life support systems operated in radiation environments, and the first data on its response to ionizing radiation are presented. The response of the algal cell to ^{60}Co gamma radiation was measured in terms of survival (colony forming ability). The absorbed dose rate was 15 kR/min, and survival curves are shown. It was found by administering the doses in two fractions separated by known periods of time that sublethal damage repair occurred, and the repair rate was estimated; maximal repair was achieved within 3 hr. The variation of radiosensitivity with cell age was also studied, and a pronounced age dependence was found, radiation sensitivity increasing between the ages of 3 and 5 hr. Probable mechanisms for these findings are discussed. Also studied was the influence of sublethal damage repair on age-response. Details are given of experimental techniques used. (UK)

33657 CYTOGENETIC EFFECTS OF GAMETOPHYTE IRRADIATION IN DURUM WHEAT. Saccardo, F. (CNEN, Rome). Radiat. Bot.; 12: No. 1, 31-5(Feb 1972). (In French).

Plants of durum wheat cv. Cappelli were acutely irradiated in the Casaccia gamma field (^{60}Co source) at different developmental stages of their gametophytes. M_1 were raised following irradiation of male gametophytes, female gametophytes and both male and female gametophytes. The total exposure was 1500 R for male and female gametophytes irradiated separately, and, 750, 1500, 2250 and 3000 R for both gametophytes irradiated together. Cytological analysis of the root tips of the M_1 plants shows that the gametophyte irradiation is a suitable technique to obtain aneuploid plants and plants with large chromosomal deletions. During this analysis, five plants with dicentric chromosomes were observed. These dicentric chromosomes are unstable and the "breakage-fusion-bridge" cycle carries out a mixochimeric situation probably responsible for the variegated leaves of these plants. The comparison of the irradiated stages shows that the female gametophyte is very radioresistant while the mononucleate stage of the male gametophyte is more radiosensitive than the bi- and the trinucleate stages. Cytological analysis of the progenies coming from the M_1 plants with dicentric chromosomes shows the transmissibility of these chromosome aberrations. (auth) (UK)

33658 INDEPENDENCE OF PROPAGATION ABILITY AND DEVELOPMENTAL PROCESSES IN IRRADIATED CELLULAR SLIME MOLDS. Deering, R. A.; Adolf, A. C.; Silver, S. M. (Pennsylvania State Univ., University Park). Int. J. Radiat. Biol.; 21: No. 3, 235-45(Mar 1972).

When assayed for reproductive ability, the cellular slime mould Dictyostelium discoideum NC-4 was resistant to ^{60}Co gamma-rays (D_{10} = 300 krads) whereas a derived mutant, γs-13, was much more sensitive (D_{10} = 4 krads). If ability to proceed through development to form normal-appearing spores (a process requiring neither DNA synthesis nor cell division) were assayed after irradiation of amoeboid cells, the γs-13 strain was more sensitive than NC-4, but the differential sensitivity was only about 4× at the 20 percent level (270 krads for NC-4). When the reproductive ability of these spores was determined, those of γs-13 were mostly inviable at doses above 20 krads, while those of NC-4 are largely viable up to 200 krads. Quantitatively, the proportion of viable spores among those produced closely follows the proportion of viable cells in the irradiated population used to initiate development. The greatest diminution of spore production occurred for irradiation done at the beginning of aggregation; however, the viability proportions among the spores that did appear did not vary with stage of irradiation. It was concluded that: cells incapable of further reproductive division could still differentiate into spores, the spores so produced retain the reproductive characteristics of the cells from which they developed; there was little if any selection during development in favor of viable cells becoming spores; a radiation-sensitive stage for development occurred at the beginning of aggregation; and the somewhat greater developmental sensitivity of γs-13 supported the view that at least some transcription is necessary during development in this organism. (UK)

33659 MUTATION BREEDING OF ACHIMENES. Broertjes, C. (Inst. of Atomic Sciences in Agriculture, Wageningen, Netherlands). Euphytica; 21: 48-62(1972).

Freshly cut leaves of Achimenes cv. Paul Arnold were irradiated with x-rays or fast neutrons, or treated with colchicine and then allowed to root and form adventitious buds. As found previously in Saintpaulia and Streptocarpus, almost exclusively solid, non-chimeral mutants or tetraploids were, respectively, obtained by using the adventitious bud technique, demonstrating that the apex of such buds originates from single cells. Although the heterozygosity of the original material apparently was not large, a relatively wide mutation spectrum was observed among the mutants produced. After competitive judging, three mutants were awarded a Certificate of Merit and have been commercialized. Two of these are earlier flowering mutants (Early Arnold and Spring time), the third having a more compact form (Compact Arnold). (auth) (Netherlands)

33660 MOLECULAR FORMS OF SOME ENZYMES FROM THE SEEDS OF ONE MAIZE INBRED AND THE MUTANTS OBTAINED BY NEUTRON IRRADIATION. Alexandrescu, V.; Sutka, I.; Hagima-Calin, I.; Popov, D.; Mihailescu, F. Stud. Cercet. Biochim.; 14: No. 3, 263-7(1971). (In Rumanian).

Neutron irradiation of maize inbred seeds (WF 9) led to two mutants: dwarf (Mu 9) and tall (Mu 14). The analysis of the enzymograms of peroxidase, catalase, acid phosphatase and amylases from the normal inbred embryos and endosperm compared with those of the mutants shows that the first two enzymes present qualitatively and quantitatively different molecular forms while the last two evince only slight quantitative differences. We believe that neutron irradiation modified the equilibrium of growing factors and did not act directly on the biosynthetic sites of the enzymes under study. (Rom. Sci. Abstr.)

33661 MODIFICATION IN AUXIN CONTENT OF ZERNA INERMIS PLANTS FOLLOWING ^{60}Co GAMMA IRRADIATION OF SEEDS. Hurghisiu, I.; Brezeanu, A. Stud. Cercet. Biochim.; 14: No. 3, 275-83(1971). (In Rumanian).

The auxin content was determined in plants of Zerna inermis (grass) originating in seeds irradiated with ^{60}Co gamma rays in doses of 5000, 10,000 and 15,000 R. Determinations were carried out in the course of plant vegetation period; samples were collected 30 and 90 days after sowing; from control plants samples were taken in the second year of vegetation. The increase in the irradiation dose of seeds induces the decrease in auxin content. An accumulation of auxin in the tillering buds was found 30 days after sowing, as an unknown X fraction; after 90 days, this fraction occurs as 3-indolyl-butyric acid. The number of inhibition fractions in the Avena test is prevailing. A different number of fractions varying with the organ and the vegetation period of plants could be separated by paper chromatography. 3-Indolyl-propionic and 3-indolyl-butyric acids, were frequently found; sometimes 3-indolyl-acetic acid, 3-indolyl-acetic acid plus tryptophan, and a non-identified X fraction were also found. A correlation seems to exist between the accumulation of growth substances within tillering buds and the organogenesis. (Rom. Sci. Abstr.)

33662 DETERMINATION OF THE TIME OF FAST REJOINING PROCESSES AFTER γ-RAY FRACTIONATED EXPOSURES IN NIGELLA CHROMOSOMES. Moutschen, J.; Gilot-Delhalle, J.; Thakare, R. (Univ., Liege). Experientia; 28: No. 2, 219-20 (15 Feb 1972).

Dry seeds of Nigella damascena were gamma irradiated with two exposures of 4 Krads separated by intervals of 2 to 4 min with constant increments of 10 sec. One series of seeds was treated with the chelating agent, diethyl-dithiocarbamate, and seeds were sown immediately. The frequencies of various kinds of chromosome aberrations were studied and tables are presented showing the relation between time intervals of fractionated exposures and numbers of aberrations. A significant decrease in the amount of aberrations occurred in the interval between 2 min 10 sec and 2 min 20 sec. During the same 10 sec interval a significant increase in chromosome aberrations occurred in seeds treated with the chelating agent. (H.L.W.)

33663 X-RADIATION EFFECT ON SOME SPECIES OF ACTINOMYCETES. Tulemisova, K. A.; Shigaeva, M. Kh.; Romankulov, T. O. Tr. Inst. Mikrobiol. Virusol., Akad. Nauk Kaz. SSR; 15: 12-18(1970). (In Russian).

The effect of x radiation on Strain 1618, Actinomycetes, closely related to Act. griseoruber, and Act. coelicolor (17/65) was studied, employing doses of from 1,500 to 30,000 R. The survival rates of the two strains were significantly different: 67.5% and 22.1% for 1618 and 17/65 respectively, at 1,500 R; and 15.9% and 4.5% at 15,000 R. X irradiation exhibited a greater lethal effect and less mutagenic effect for strain 17/65. A large number of variants in strain 1618 were caused by 4,500 R; in strain 17/65 by 9,000 R.

The antibiotic activity of some variants of strain 1618 exceeded the original activity by 3 to 4 times; for strain 17/65 by 3 times. An analysis of the biochemical mutants is given. (K.S.W.)

33664 EFFECT OF COMBINED TREATMENT OF SEEDS WITH MUTAGENS AND GROWTH REGULATORS ON VIABILITY AND GROWTH OF ACER NEGUNDO L. SEEDLINGS. Privalov, G. F. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Genetika; 8: No. 2, 36-45(Feb 1972). (In Russian).

Three effects of the combined treatment of seeds with mutagens (ethyl methane sulphonate, x-rays and nitrosoethyl urea) and growth regulators (indolyl acetic acid and indolyl butyric acid) are described: increased viability of plants after treatment of seeds with growth regulators in a high concentration (1.0%); decreased height of seedlings after the use of growth regulators in stimulating concentrations (0.1% and 0.01%); and change in the ratio between seedlings with "stable" and "unstable" height increment, as estimated by internode length. (auth)

33665 GENETIKA I TSITOLOGIYA. (Genetics and Cytology). Turbin, N. V. (ed.). Minsk; Izdatel'stvo BGU im. V. I. Lenina (1970). 208p.

This book represents a collection of 30 papers by various authors on experimental studies of polyploidy and diploidy, seed alkaloids, disturbances of meiosis, hybrid characteristics, and other factors relating to the genetics and cytology of plants. Seven (of the 30) papers discuss biological and genetic effects of ultraviolet, x radiation, 42 MeV electrons, and gamma rays on plants and their seeds. Experiments on Drosophila are reported in two of the papers. (K.S.W.)

33666 ANALYSIS OF DESYNAPTIC MUTANTS INDUCED IN DURUM WHEAT (TRITICUM DURUM DESF.). Bozzini, A. (CNEN, Casaccia, Italy); Martini, G. Caryologia; 24: No. 3, 307-16(1971).

Five desynaptic mutants isolated in M_2, confirmed in M_3, and cytologically analyzed in M_4 were investigated. Two of these (DS_1 and DS_2) were isolated in the cv. Cappelli after seed treatment with ethylmethansulfonate (EMS) and thermal neutrons respectively. The other three (DS_3, DS_4, and DS_5) were isolated in the cv. Aziziah after seed treatment with thermal neutrons, EMS, and fast neutrons, respectively. For genetic analysis of mutation, the segregation ratio for each mutation was calculated in individuals of five generations (from M_3 to M_7). To ascertain whether the cytological behavior was influenced by the environmental conditions, a DS_1 mutant was grown both in field and controlled conditions (20°C, 12.000 lux for 18 hrs per day) in a growth chamber. In all five mutants, the behavior during microsporogenesis was almost the same. In fact, no significant difference in the mean number of chiasmata per cell was found either between the two control lines (Cappelli and Aziziah), or between the two mutant lines of Cappelli (DS_1 and DS_2) or among the three mutant lines of Aziziah (DS_3, DS_4, and DS_5). By contrast, a significant difference was found between desynaptic lines derived from Cappelli and desynaptic lines derived from Aziziah. No clear difference at the cytogenetic analysis was found in individuals derived from the DS_1 mutant line grown in the field and in the growth chamber. This means that the environmental conditions do not influence the meiotic behavior of the mutants. The number of laggards per anaphase I and II, the mean number of micronuclei per diad and tetrad, and the percentage of pollen fertility (by staining with propiono-carmin) were also taken into account. In all mutants no clear difference was observed. The genetic analysis of the segregation ratio of the five mutants shows a monogenic recessive behavior of the mutations. (INIS)

33667 INFLUENCE OF SHORT-TERM THERMAL TREATMENT UPON THE STABILITY OF SEEDS TO X-IRRADIATION AND TO OTHER INJURING AGENTS. Babayan, R. S. (Lab. of Induced Mutagenesis of Plants, Erevan). Tsitologiya; 14: No. 3, 342-51(Mar 1972). (In Russian).

When seeds of wheat undergo a short-term (up to 30 min) thermal treatment (35 to 50°C, sprouting seeds, 60 to 90°C air-dry seeds), their stability towards ionizing irradiation is increased. The aim of the study was to check whether or not the increased stability of seeds towards ionizing irradiation was only a particular case of the reactive increase of stability due to the thermal treatment. For this, seeds, that underwent the thermal treatment, were affected with some different factors (high temperature, ethylenimine, hydroxylamine, alcohol, acetone). The stability of seeds to these factors was found to increase too. The evidence presented may suggest that seeds previously treated with high temperature increase their total stability, the phenomenon being of a non-specific nature, which may be due to conformation changes of cell proteins. (auth)

33668 STUDIES ON THE RADIATION BREEDING OF FOREST TREES. Ohba, Kihachiro. Acta Radiobot. Genet.; No. 2, 1-98(Aug 1971).

The radiosensitivity of Pinus sylvestris, Pinus densiflora, and Cryptomeria japonica was studied following exposure of seeds to various doses of gamma and x radiation. Radiosensitivity was expressed by germination ability, growth inhibition, and seedling mortality. Cytological investigations showed that growth inhibition and seedling mortality were related to cytological disturbances such as radioinduced chromosome bridges and fragments. Results of studies conducted since 1962 on the effects of acute and chronic gamma radiation on survival of seven coniferous and ten broad-leaved tree species are presented. The most conspicuous effect of radiation was growth inhibition in the exposure range of about 10R/day for conifers and about 80 to 100R/day for broad-leaved trees. Several kinds of somatic mutations were detected including chlorophyll, morphology, and wax covering. A sharp exposure rate dependency in somatic mutability was noted under chronic gamma radiation and optimum exposure rates were estimated as 10R/day for conifers and 50 to 70R/day for broad-leaved trees. Studies were also conducted on variation in forest trees with special reference to some major genes and to fertilizer response. (H.L.W.)

33669 HIGH PROTECTIVE ACTION AGAINST GAMMA RADIATION DAMAGE, BY A TRYPTOPHAN–ETHANOL MIXTURE. Sanchez, G.; Hasbun, S.; Diaz, E.; (and others). (Univ. Chile, Santiago de Chile. Comision Nacional de Energia Nuclear, Santiago de Chile). Z. Naturforsch.; 27b: No. 5, 544-9(May 1972).

From a group of nonsulphydryl radioprotectors (methanol, formaldehyde, acetaldehyde, formiate, acetate, ethanol, and tryptophan); ethanol and tryptophan were selected because of high protective action on irradiated purine and pyrimidine bases. At molarities of the order of 10^{-4} for tryptophan–ethanol and bases and DNA the respective DRF values were: for guanine: 20.58; for adenine: 3.75; for thymine: 4.94; for cytosine: 5.52; for uracil: 5.43; and for DNA: 18.95. For irradiated seeds protected with tryptophan-ethanol (1.5×10^{-3} M; 2.6×10^{-2} M) the DRF value was of 3.33 and radiation damage became evident only after a total dose of 2×10^4 rads. A partial different mechanisms for radioprotection with ethanol and tryptophan is postulated; this is supported by the fact that when tryptophan molarities attains that of protected DNA, there are a rapid increase in its values of DRF, crossing up the ethanol protection curve. Actually tryptophan could act not only as a radical scavenger, but also, as localized radical quencher and/or energy trapper. (auth)

Radiation Effects on Animals (External Source)

Man

Refer also to abstracts 33326, 33833, 33907, 35185, and 35221.

33670 (LIB/Trans-361) FORMATION OF DICENTRIC CHROMOSOMES IN HUMAN LYMPHOCYTES SUBJECTED IN VITRO TO A FLUX OF MIXED RAYS (GAMMA AND NEUTRONS). Biola, M. T.; Le Go, R.; Ducatez, G.; Dacher, J.; Bourguignon, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by M. Ganez for Australian Atomic Energy Commission, from report CEA-CONF-1723. 15p. Dep. NTIS (U. S. Sales Only).

An abstract of this report was prepared from the original language publication and appeared in NSA Vol. 25 as number 32591. (C.H.)

33671 (SGAE-IB/IA-25/1972) EXTRACORPOREAL BLOOD IRRADIATION FOR TREATMENT OF LEUKEMIA. Cless-Bernert, T.; Frischauf, H.; Honetz, N.; Madl, W.; Mittermayer, K. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). Jan 1972. 9p. (In German). Dep. NTIS (U. S. Sales Only).

Methods of extracorporeal β-irradiation of human blood are discussed. Advantages of the Cimino-shunts are discussed in comparison with Scribner-shunts. The use of extracorporeal blood irradiation for the treatment of six patients suffering from chronic leukemia is reported. In four patients, a noticeable reduction in the size of lymph nodes occurred. In one case, lymph nodes increased in size and diminished following additional therapy. In one patient, the radiation dose was too small to elicit a significant therapeutic effect. It was concluded that extracorporeal irradiation of blood is a valuable tool for the treatment of chronic lymphatic leukemia. (H.B.G.)

33672 RADIATION DAMAGE AND RADIATION PROTECTION. DAMAGE BY IONIZING RADIATION (ESPECIALLY LATE EFFECTS). Fischer, H. Muenchen. Med. Wochenschr.; 112: No. 13, 591-5(1970). (In German).

A review is given of results of investigations of persons exposed to ionizing radiations either because of their profession, or due to radiotherapy or accidents. The following subjects are dealt with: damage after therapeutic irradiation, skin lesions caused by professional exposure, radiation effects on eyes and kidneys, acute radiation syndrome, histopathology of radiation injuries, radiation effects on cells, leukemia in Hiroshima and Nagasaki, leukemia in children of persons having survived the nuclear explosions, judgement of head size and cerebral retardation in children exposed in womb, testicular changes of survivors, results of cytologic investigations, occurrence of myelofibrosis and myeloic metaplasia, aging, death rate, mortality due to malignant neoplasms, carcinomas of lungs, mammary glands and thyroid. (INIS)

33673 ROENTGENOLOGICAL PICTURE OF PNEUMOSCLEROSIS IN PATIENTS WITH PULMONARY CANCER IN LATE TERMS AFTER THE RADIATION THERAPY. Pereslegin, I. A.; Savina, E. B. (Moscow Medical Inst.). Vop. Onkol.; 18: No. 1, 102-9(1972). (In Russian).

The results of observations on 53 patients with pulmonary cancer in the postradiation period (19 patients-2 yrs and longer follow-up, 17 patients-3 yrs and longer, 7 patients-over 4 yrs, and 5 patients-over 10 yrs) are reported. The conclusion is drawn on regularities of marked postradiation changes (reliable statistically). The peculiarities of postradiation pneumosclerosis in patients with pulmonary cancer in comparison with patients having intrathoracic tumors of other localizations are emphasized. (auth)

33674 PHYSICAL PROBLEMS IN PROTECTION AGAINST IONISING RADIATION. Fava, Giannino; Sichirollo, Adele E. (Istituto Nazionale Tumori, Milan). Radiol. Med.; 57: No. 4, 293-302(Apr 1971). (In Italian).

External irradiation exposure data on the personnel at the National Institute for the Study and Treatment of Tumors at Milan are reported and discussed. The data were collected during 1962 to 1969. (E.R.B.)

33675 MULTIPLE BASAL CELL EPITHELIOMA PRODUCED ON RADIUM RADIATION-DAMAGED SKIN. Honma, Hiroko (Niigata Univ., Japan); Nitto, Heita. Hifuka No Rinsho; 12: No. 13, 1134-42(Dec 1970). (In Japanese).

A case is presented of three dark brown tumors produced on the skin damaged by radium radiation. Their histological examination revealed the presence of epidermal epithelioma besides basal cell carcinoma. The subject was a 41-year-old male who had received radium irradiation for a few years for congenital reddish eruptions (spongy hemangioma) on the left side of his face, from below the eyes to the upper part of the cheek. The skin below the left eye was swollen and pigmentation and depigmentation were mixed over the upper part of the cheek, with dilatation of the capillary blood vessels. Small bluish black spots were seen in the periphery of the dermatitis area, where the skin damage was slight. These were of the same height as the epidermis and the surface was smooth. There were also two black eruptions (spots) with small central ulcerations. The skin damaged by radium was excised and skin transplantation was carried out. Histological examinations were made on the small black spot, tumorous lesions, and a large ulcer, stained with hematoxylin and eosin, and with periodic acid-Schiff reagent. Some considerations were made of the lesion of epidermal epithelioma type, and the relationship between basal cell epithelioma and radiation-damaged skin was described. (Japan)

33676 IATROGENIC RADIATION DAMAGE AND ITS THERAPY. Lichtigfeld, F. J. Strahlentherapie; 142: No. 6, 681-5(Dec 1971).

A case of radiation-induced severe gastrointestinal bleeding not possible to treat completely by surgical intervention is described. Various medical means to protect normal tissue during radiation therapy are mentioned, including the use of flavinoids, non-absorbable sulpha drugs, and diphospho-pyridine nucleotide containing compounds. The late effects of radiation therapy on hollow visceral organs are detailed and the common factor of radiation vasculitis leading up to them is discussed. Methods of healing radiation damaged tissue, both experimentally and clinically, are mentioned as are the substances used to control bleeding from the innate form of telangiectasia, viz. hereditary haemorrhagic telangiectasia. A combination of these medicines proved therapeutic in this case, in particular the use of a de-proteinized blood extract given intravenously over a period of six months, viz. solcoseryl. It has been used to heal tissue damage, caused by impaired blood supply, by means of improving oxygen utilization. This is the first recorded instance of the successful medical therapy of radiation-induced severe gastro-intestinal bleeding, with the use of solcoseryl playing a major role in the treatment. (auth)

33677 NOTE ON THE USE OF RBE, QUALITY FACTOR, AND OTHER MODIFYING FACTORS BY ICRP IN THE CALCULATION OF MAXIMUM PERMISSIBLE DOSE FOR BONE. Marley, W. G. pp 723-7 of Contamination by Bone-Seeking Radionuclides and Radioprotection. Montrouge, France; Societe Francaise de Radioprotection (1971). (CONF-710211-2).

From fifth international meeting of the French Society of Radiation Protection; Grenoble, France (1 Feb 1971).

The latest recommendations of the ICRP Main Commission (Publication 9, adopted September 1965) favors the use of a quality factor (QF) allowing for differences in LET. It is to be noted that the term QF is used as distinct from RBE, which is reserved for quantities derived directly from specific biological experiments. (France)

33678 CAPILLARY MICROSCOPIC EXAMINATIONS IN THE AGED, THE IRRADIATED, AND ATROPHIC SKIN. Iwaizumi, Kunio (Kanazawa Univ., Japan). Nippon Hifuka Gakkai Zasshi; 81: No. 3, 216-39(Mar 1971). (In Japanese).

Vascular changes and state of blood stream in the skin were studied by skin microscope on 10 cases of senile skin, 50 cases of control skin from young and middle-aged persons, 47 cases of skin damaged by irradiation, and 10 cases of skin atrophy. Changes in the blood vessels of the skin progress with age, such as decrease in the number and deformation of capillary loops, dilatation of subpapillary blood vessels, and granular blood stream. Vascular changes were greater in the exposed skin than the covered skin. Vascular images of the skin irradiated with divided doses of radiation showed no difference between soft x-ray and ^{60}Co γ-ray irradiation. Under the skin microscope, reddening of the skin appeared with 600 R dose, hyperemia and dilatation of capillary loops occurred, and these changes became maximum with a dose of 1200 R. Beyond the dose of 1800 R, hyperemia in the subpapillary blood vessels and capillary loops decreased, dilatation of subpapillary blood vessels and granular blood stream were noted, and these changes became constant with the total dose above 3000 to 4000 R. Local application of adrenaline and pilocarpine resulted in the strongest reaction of skin blood vessels at a total dose of 1200 R and no reaction was observed beyond 3000 R. Vascular changes in chronic radiation dermatitis include decrease, dilatation, and deformation of capillary loops, dilatation and deformation of subpapillary blood vessels, and impediment in blood stream. These changes increased to some extent with increasing doses of irradiation but the subpapillary blood vessels became rigid above 9000 R. In this case, vascular reaction to adrenaline and pilocarpine was decreased and became unreactive with a higher dose. Blood image in skin atrophy included decrease and deformation of capillary loops, dilatation of subpapillary blood vessels, and impediment of blood stream, with lowered vascular reaction to adrenaline and pilocarpine. (Japan)

33679 CERVITRON-II. A NEW INSTRUMENT FOR INTRACAVITARY RADIOTHERAPY. Cardis, Raymond; Kjellman, Jean. Acta Oncol.; 9: 226-31(Jul-Dec 1970). (In Spanish).

A new automatic device for intracavitary radiotherapy using ^{137}Cn is described. The device is mobile, has great flexibility, and guarantees total radiation protection. Two patients may be treated simultaneously by means of six independent applicators, which have great flexibility in source spatial distribution and in treatment duration. Dosage to the two patients is controlled by individual control panels. (J.S.R.)

33680 MASTOCYTES AND CUTANEOUS REACTIVITY OF THE DELAYED TYPE. Ippolito, F.; Barduagni, O. G. Ital. Dermatol.; 44: 475-6(Sep 1969). (In Italian).

The hyporeactivity of the skin consequent to x radiation of subjects afflicted with occupational eczema is briefly discussed. The documented connection between mastocytes and histamine is cited. Mastocytes were investigated by biopsy 10 and 30 days after radiation treatment of 350 R. A significant reduction in the number of mastocytes was noted in the irradiated skin. (K.S.W.)

33681 CARCINOGENESIS: CHEMICAL AND OTHERWISE. Calvin, Melvin (Univ. of California, Berkeley). Radiat. Res.; 50: No. 1, 105-19(Apr 1972).

A review is made not only of the kinds of chemicals which are carcinogenic, but a suggestion is also given about one of the characteristics which may belong to the cells which are chemically transformed. This characteristic has already been shown to be associated with neoplastic cells produced by oncogenic viruses and constitutes the presence of a feedback enzyme having the function of an RNA-dependent DNA polymerase. It is suggested that a similar characteristic be sought in radiation-produced neoplasms, thus bringing all three neoplastic conversions together in one biochemical sense. A class of drugs has already been found which inhibits this presumably characteristic enzyme, and the transformation of tissue cultures by oncogenic viruses has been shown to be inhibited by suitable concentrations of this drug. (auth)

33682 DEUTSCHER ROENTGENKONGRESS, 1970, VOM 21. BIS 24. MAI 1970 IN MUENCHEN. (German X-Ray Conference, 1970, May 21–24, 1970, Munich, Germany). Hug, Otto (ed.). Stuttgart; Georg Thieme Verlag (1972). 166p. (CONF-700569–(Absts.)).

Abstracts of 150 papers presented at the conference are included. In the experimental radiobiology section, cell proliferation, radiosensitivity, and time dependency were discussed for normal and malignant tissues. Under diagnostics, radiography of the infant abdomen is discussed; and in the therapy section, radiation treatment of renal tumors and radiation-induced disturbances of kidney function are discussed. Additional subjects include: the diagnosis of inflammatory rheumatic diseases of the skeletal system; ultrasound diagnosis as a supplement to radiological procedures; radiation effects on the nervous system; and parenchymatose kidney diseases. Renal diseases are also discussed from the standpoint of angiography, scintigraphy, the diagnosis of tuberculosis, and kidney transplants. The proceedings concluded with a discussion of dosimetry problems and with a discussion on radiation protection. (H.B.G.)

33683 IN VITRO DOSE-RESPONSE RELATIONSHIP FOR CHROMOSOMAL ABERRATIONS IN PERIPHERAL BLOOD LYMPHOCYTES AS A REFERENCE SYSTEM FOR IN VIVO BIOLOGICAL DOSIMETRY OF IONIZING RADIATION. Liniecki, Julian (Inst. of Occupational Medicine, Lodz, Poland). Prac. Lek.; 24: No. 2-3, 86-92(Mar 1972).

Potential usefulness of chromosomal aberrations in peripheral blood lymphocytes as a biological dosimeter is emphasized. As a first step toward quantitative evaluation of dose after in vivo irradiation of man a reference system (adequate dose-effect relationship) must be obtained irradiating the cells in vitro. The influence of several factors (culture time, age and sex of blood donors, quality of radiation, stimulation of the cells with phytohaemagglutinin, oxygenation and temperature at irradiation) upon the yield of dicentrics and character of the dose-effect relationship in lymphocytes irradiated in vitro is reviewed. Conditions for this irradiation, most adequately simulating the in vivo situation, are specified. (auth)

33684 RADIOBIOLOGY OF LYMPHOCYTES: THE USE OF EXTRACORPOREAL IRRADIATION IN EXPERIMENTAL RADIOPATHOLOGY. Pompidou, A.; Girard, J. F. (CEN, Fontenay-aux-Roses, France. Centre Hospitalier Univ., Paris). Pathol.-Biol.; 19: No. 9-10, 511-22(May 1971).

Lymphocytes are very sensitive to irradiation. Extracorporeal irradiation of the blood enabled the dynamics of the renewal process to be studied. This method allowed problems related to lymphocytes in delayed hypersensitivity reactions, graft rejections, and also certain affections with dysimmune factors to be treated. The technique has been used to treat certain hemopathies. Extracorporeal irradiation of the blood aimed at producing immunosuppression results in a decrease in the cell immunity reactions and a humoral persistence immunity (after prolonged treatment). The application of radiobiology to the study of lymphocytes, and particularly extracorporeal irradiation of the blood, to experimental pathology should confirm the hypotheses suggested for the heterogeneity of the lymphocyte populations. A better treatment of immunity disorders should be possible through the association of antimetabolites and immunosuppressives with extracorporeal blood irradiation techniques. (France)

33685 CARDIAC AFFECTION IN BURNS, EXPOSURE TO RADIATION, LARGE BLOOD LOSSES, AND INJURIES. Teodori, M. I.; Momot, M. D. Ter. Arkh.; 43: 29-35(Sep 1971). (In Russian).

Using current methods for clinico-instrumental and laboratory investigations the authors studied the cardiac condition of patients with deep and expansive burns, those subjected to intensive radiation therapy in connection with malignant diseases of the organs of the thorax (lungs, mediastinum, mammary gland); patients with profuse internal hemorrhages and with an open and closed trauma of the heart. In a severe burn disease myocardial changes were most frequent the nature and extent of which correlated with the severity of the burn course. In the acute (shock) period dystrophic and necrobiotic changes of the cardiac muscle associated with microcirculatory disorders, microthrombosis in the coronary system of the heart and electrolyte metabolic disorders. At later periods alongside dystrophic changes of the myocardium there were observed inflammatory processes in the interstitial tissue of the heart, more seldom in the pericardium and endocardium. In intensive radiation exposure when the area of irradiation was located close to the heart, sometimes dystrophic (reversible), more seldom inflammatory changes in the myocardium and pericardium took place; the ECG showed changes of the ischemic type, sometimes with a picture characteristic of myocardial infarction. In profuse hemorrhages and development of acute posthemorrhagic anemia sinus tachycardia was observed, systolic noise in the apex of the heart developed, sometimes pain in the heart region and behind the sternum and the ECG recorded changes of the ischemic type apparently caused by hypoxy of the myocardium. The clinical picture, course and ECG changes in open and closed lesions of the heart are described. (auth)

33686 EFFECT OF LOCAL RADIOTHERAPY ON THE ANTIBODY LEVELS AGAINST EBV-INDUCED EARLY AND CAPSID ANTIGENS (EA AND VCA) IN PATIENTS WITH CERTAIN MALIGNANT TUMOURS. Einhorn, N.; Henle, G.; Henle, W.; Klein, G.; Clifford, P. (Karolinska Inst., Stockholm. Children's Hospital, Philadelphia. Univ. of Pennsylvania, Philadelphia. Kenyatta National Hospital, Nairobi, Kenya). Int. J. Cancer; 9: 182-92(1972).

Antibodies to tumor-related and EBV-associated intracellular antigens were studied in 14 cases of Burkitt's lymphoma, 50 of nasopharyngeal carcinoma, 10 of maxillary carcinoma and 95 cases of other tumors, all of whom received radiotherapy in Nairobi. For up to 1 month after radiotherapy the cases of Burkitt's lymphoma recorded an increase in antibodies to early antigens (EA) amounting to, on average, about one titre step ($p < 0.001$). During the same interval there was a small but significant increase in antibodies to viral capsid antigen (VCA) (mean 0.6 titre step; $p < 0.001$). The patients with nasopharyngeal and maxillary carcinoma, too, showed a small but statistically significant increase in antibodies to VCA 2-6 months after radiotherapy ($p < 0.01$ and 0.001, respectively), but no increase in antibodies to EA. On the contrary, in nasopharyngeal carcinoma patients there was a significant decrease in antibodies to EA 2-3 months after radiotherapy. In the group of other tumors there was no evidence of a change in antibodies to the intracellular antigens studied during any of the relevant intervals. (auth)

33687 ADVANCES IN GENETICS. VOLUME 16. Caspari, E. W. (ed.). New York; Academic Press, Inc. (1971). 430p. $18.00.

Critical summaries of theoretical and practical problems in genetics are presented. The discussions cover plant breeding, animal breeding, and human heredity, as well as the related fields of biophysics, biochemistry, physiology, and immunology. A separate abstract was prepared on one chapter that discusses the genetic consequences of exposure to ionizing radiations. (C.H.)

For abstract of individual chapter see: 33688.

33688 GENETIC EFFECTS OF IONIZING RADIATIONS. Newcombe, Howard B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Advan. Genet.; 16: 239-303(1971).

A review is presented of studies reported during 1967, 1968, and 1969 on the genetic consequences of exposure of cells, organisms, and populations to ionizing radiation. Topics discussed include: resistance, sensitivity, and repair of radio-induced chromosomal aberrations and gene mutations; the nature of genetic changes; scientific and practical uses of induced genetic changes; the effects of external radiation dose and dose rate, ion-density, transmutation effects, and genetic effects of incorporated radioisotopes; the relation of genetic changes to cell death and carcinogenesis; the importance of hereditary consequences in individuals and populations; and implications of the findings on human populations. (278 references.) (C.H.)

33689 OSTEOGENIC SARCOMA OF HEAD AND NECK INDUCED BY RADIATION THERAPY. Arlen, Myron; Shah, Indravadan C.; Higinbotham, Norman; Huvos, Andrew J. (Memorial Hospital-Sloan-Kettering Cancer Center, New York). N. Y. State J. Med.; 72: No. 8, 929-34(15 Apr 1972).

The use of pre- and postoperative radiation therapy in the patient with head and neck cancer appears to engender complications including the appearance of new malignant growths. During the period 1931 to 1968, 50 cases of radiation-induced osseous neoplasms were seen and seven of these tumors arose in the head and neck region. Each case met established criteria for radiation-induced osteogenic sarcoma. Other cases of the same phenomenon appearing in the literature are reviewed. (auth)

33690 COMPARATIVE ABSORBED DOSES IN PERIAPICAL RADIOGRAPHY. II. PANOREX. Weissman, Donald D.; Longhurst, Gerald E. (Univ. of California, Los Angeles). Oral Surg., Oral Med., Oral Pathol.; 33: No. 4, 661-8(Apr 1972).

The doses of x radiation absorbed during extraoral panoramic radiography were monitored with calcium fluoride thermoluminescent dosimeters at seven internal cadaver sites: in the pituitary gland, under the eyelid, in a maxillary central alveolus, in the vestibule at the first maxillary molar, in the parotid gland, in the submaxillary gland, and at the first cervical vertebra; and the exposure dose at seven external sites for adults, children, and cadaver at cornea, philtrum, skin over the first maxillary molar, over the parotid gland, over the thyroid gland, over the first cervical vertebrae, and lap above apron. Exposures were performed with an S. S. White Panorex operated at various kilovolts peak, 10 Ma., and a 22-second cycle. Sixty clinic patients and twenty cadaver sets of dosimeters were exposed. The responses acquired by dosimeters during these surveys indicated that skin entrance exposures ranged from 218 to 485 mR, while the skin exit values dropped to a range of 1.5 to 22 mR, demonstrating more than 90 percent absorption of incident radiation. Corroboration with results reported by other investigators was inconclusive because of variations in machine factors, dosimetry devices, and anatomic site monitored. (auth)

33691 X-RAY-INDUCED CHROMOSOME ABERRATIONS IN HUMAN PERIPHERAL BLOOD LEUCOCYTES: THE RESPONSE TO LOW LEVELS OF EXPOSURE IN VITRO. Kucerova, M.; Anderson, A. J. B.; Buckton, K. E.; Evans, H. J. (Western General Hospital, Edinburgh). Int. J. Radiat. Biol.; 21: No. 4, 389-96(Apr 1972).

The human peripheral blood of three healthy donors was irradiated in vitro with small x-ray doses: 5, 10, 15, 30, and 50 R, and 1500 cells were scored at each dose level for aberrant chromosomes, dicentric and ring chromosomes, and acentric fragments. A significantly higher number of chromosomal aberrations was found only after doses of 30 and 50 R. There was no significant variation in response between cells of all three donors. Over the range of doses used, the dose–response curve(s) appeared to be linear. (auth)

33692 DELAYED RECONSTRUCTION FOR POSTRADIATION DEFECT OF THE MIDDLE EAR. CASE REPORT. Luangkesorn, Prasert; Donaldson, Robert C.; Paletta, F. X. Missouri Med.; 68: No. 11, 848-50(Nov 1971).

A case of radiation osteochondronecrosis of the ear treated by surgery for epidermoid carcinoma of the left middle ear is reported. There was no evidence of recurrence of the cancer during a 16-month postoperative period. (auth)

33693 CALCULATED DOSE RATE FROM ^{252}Cf RADIOTHERAPY SOURCE. Stoddard, D. H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Radiology; 103: No. 1, 187-90(Apr 1972).

The radiation dose rate from a ^{252}Cf needle designed for radiotherapy was calculated using the ANISN code. From the calculated data, neutrons and gamma rays are divided into 22 energy groups, which are a prediction of the spectrum at the point of interest. These calculated data are compared with experimentally measured data which apply to a ^{252}Cf needle immersed in a tissue-equivalent solution. (auth)

33694 DEPTH DOSE IN SKIN FOR OBLIQUELY INCIDENT ^{60}Co RADIATION. Orton, Colin G.; Seibert, Jean B. (New York Univ., N. Y.). Brit. J. Radiol.; 45: No. 532, 271-5(Apr 1972).

Clinical observations showed that much of the skin-sparing effect of ^{60}Co radiation was lost if the beam were incident obliquely on the skin. This was most evident with tangential irradiation. LiF thermoluminescent powder was used to determine the build-up of dose in the superficial layers of skin of a tissue-equivalent phantom. Dose measurements at several skin depths were made for various values of angle of incidence, field size and collimator skin distance. The dose to the basal layer of the epidermis increased with increase in both field size and angle of incidence, but was independent of epidermal thickness. The maximum dose to the dermis occurred for angles of incidence between 60° and 90° and varied little with field size and dermal thickness. The results could be related to observed skin reactions. (UK)

33695 PROBLEMS ARISING IN ESTIMATING FROM RETROSPECTIVE SURVEY DATA THE LATENT PERIODS OF JUVENILE CANCERS INITIATED BY OBSTETRIC RADIOGRAPHY. Kneale, G. W. (Oxford Univ.). Biometrics; 27: 563-90(Sep 1971).

Starting from the hypothesis that the carcinogenic effects of prenatal x rays are a direct consequence of the mutagenic actions of ionizing radiations, and that the malignant diseases so caused (radiogenic cancers) have a different age distribution from other juvenile malignancies (idiopathic cancers), methods are developed for solving the problems posed by the limitations of the available data (Oxford Survey of Childhood Cancers). Explicit formulae for estimating the number of radiogenic cases in a simple situation are derived. The problems of truncated contingency tables and a simple approximate method for them are discussed. It is shown that in the situation described, minimum modified chi-square estimation can be more effective for multinomials than maximum likelihood. It is demonstrated that the possibility of a memory effect in the records of x raying can be discounted, and that radiogenic cases are genuine. It is shown that each diagnostic group has a characteristic radiogenic age distribution that differs from the corresponding idiopathic age distribution in being more sharply peaked and having a slightly older mean age. Small changes in the age distributions due to improved methods of diagnosis, etc., are demonstrated. Irregular changes in the cohort trend of the radiogenic hazard due to alterations in x-raying practice, etc., are shown. (auth)

33696 GENETICAL EFFECTS OF RADIATION ON POPULATIONS. Berry, R. J. (Royal Free Hospital, London). At. Energy Rev.; 10: No. 1, 67-100(Mar 1972).

Four to 6% of the human population at birth suffer from inherited defects, representing a considerable physical and social burden. At a time when concern about chemical mutagens in the atmosphere is increasing, it is pertinent to review the effects of ionizing radiation on the incidence and persistence of new mutations in the population. Current ideas of the population dangers of mutation are strongly influenced by H. J. Müller's Bunyanesque concept of genetic load (which, in Müller argued, is on the verge of becoming too heavy for the human species to carry). The discovery that animals (including man) are heterozygous at something like one in ten of their gene loci has focused attention on the mechanisms whereby variation is maintained in populations. Much research has been devoted to assessing the relative importance of the "mutational" and "segregational" loads. Only the former is directly affected by any increase in mutation rates. The "load ratio" at one time promised to be able to separate mutational from segregational loads. Unfortunately it has not proved efficient and recourse in interpretation and polemic has had to be to experiment. Studies of putative induced mutation in man as affecting the sex ratio, the frequency of congenital malformations, and the incidence of chromosomal anomalies show no more than that man is not unduly genetically radiosensitive. However, irradiation of animal populations has repeatedly led to the production of some mutations behaving as overdominants (i.e. heterotically). The abundance of variation (particularly isozymic) in populations is interpreted by some as representing neutral mutation. However, every example that has been investigated has shown the action of natural selection. There can be no doubt that a greater proportion of variation than was once thought is maintained by balanced selection. The greater this proportion, the lower are the genetical risks of radiation. (auth)

33697 MEASURES FOR REDUCING THE ABSORBED DOSE BY THE PATIENT IN X-RAY DIAGNOSIS. Torretta, A.; Reis, F.; Pini, M. (Ospedali Riuniti, Trieste, Italy). Minerva Med. Giuliana; 62: 782-3(24 Feb 1971). (In Italian).

Measures recommended for reducing the administered dose in roentgen diagnostics are grouped into two criteria types: general criteria, which should always be observed in diagnostic practice, and special, or protective measures dictated by the type of examination. General criteria include constant voltage generators, hard rays, use of filters, increasing the focus to subject to film distance, limitation in the beam amplitude, and use of lead shielding to cover sensitive organs. Special criteria are extremely varied, but consideration is given to excluding the gonads from exposure whenever possible. (K.S.W.)

33698 TREATMENT OF RADIATION EPITHELITIS AND EPIDERMITIS IN PATIENTS WITH NEOPLASMS OF THE UPPER RESPIRATORY TRACT BY METACIL AND MERADIN. Manyuta, A. I. Zh. Ushnykh Nosovykh Gorlovykh Bolez.; 30: 46-51(Sep-Oct 1970). (In Russian).

One hundred and eighty patients with radiation injuries of the epithelium and epidermis arising as a result of distance gamma-ray treatment of malignant neoplasms of the upper respiratory tract were observed. Clinical observations were conducted parallel to the laboratory investigations by the method of successive washings of the mucous membrane of the pharynx and nose and examination of the cells. The radiation epitheliitis was treated with 4-methyluracil (metacil) and 8-mercaptoadenin (meradin). The clinical improvement observed in the patients that received metacil and meradin was corroborated by the data of intensity of leukocyte emigration and the degree of desquamation of the epithelium. Metacil and meradin not only produced an anti-inflammatory effect but also prevented the development of atrophic processes, which was revealed on examining patients one year after the termination of distance gamma-ray treatment. (auth)

33699 PARAPLEGIA DUE TO RADIATION MYELITIS FOLLOWING THE TREATMENT OF CARCINOMA OF THE BRONCHUS BY RADIOTHERAPY. Rivett, Joan D.; Path, M. R. C (Stoke Mandeville Hospital, Aylesbury, Eng.). Paraplegia; 9: 65-72(Aug 1971).

The clinical details of autopsy findings from two cases of paraplegia following the treatment of carcinoma of the bronchus by radiotherapy are given and the pathogenesis of radiation myelitis is discussed. Histopathological examination of the spinal cords revealed necrosis without gliosis, and hyaline thickening of small arteries with some endothelial proliferation. (auth)

33700 METHODS OF EARLY DIAGNOSIS OF RADIATION SICKNESS. Kolesnikov, Yu. A.; Chernenko, G. T.; Zhizhin, V. N. Med. Radiol.; 16: No. 11, 74-84(Nov 1971). (In Russian).

A review of recent literature on different reactions of the organism to acute radiation sickness is presented, with emphasis on the development of methods for early diagnosis and evaluation of the seriousness of radiation-induced injury to the organism. The more important indications of radiation injury are the changes which occur in the lymphocyte number in the blood, chromosomal aberrations in bone marrow cells, biochemical changes such as increase of urinary excretion rates of creatine, β-aminoisobutyric acid, deoxycytidine, and taurine, and lastly, biophysical changes such as measurements of radioactivity induced by neutron radiation (e.g., ^{24}Na), and changes in the electron paramagnetic resonance of biological tissue. (100 references) (K.S.W.)

33701 IONIZING RADIATION OF THE COSMIC SPACE AND SPACE FLIGHTS. Grigor'ev, Yu. G.; Efimov, V. I.; Petrov, V. M.; Kovalev, E. E. Gig. Sanit.; No. 10, 45-9(Oct 1971). (In Russian).

Radiation safety measures undertaken in space flights are described. Analysis of dosimetric investigation data proved the integral radiation doses to which the cosmonauts were exposed during the flight of the space ships, Soyuz 3, 4, 5, 6, 7 and 8, to be several hundred times smaller than the standard permissible radiation doses and to be quite harmless for the body. (auth)

Vertebrates

Refer also to abstracts 33569, 33570, and 33649.

33702 (AD–734779) BODY-WEIGHT VARIATION IN PRIMATES EXPOSED TO 55-MeV PROTONS. Final Report, January 1965–September 1971. Kirk, John H. (School of Aerospace Medicine, Brooks AFB, Tex.). Nov 1971. 9p. (SAM-TR–71–48). NTIS.

Sham-exposed controls and 55-MeV-proton irradiated primates have been periodically weighed for 7 years following whole-body surface exposure. The primates exposed at the 400- and 600-rad levels have smaller body weights than the age- and sex-matched control primates. This finding indicates a possible chronic radiation effect. (NTIS)

33703 (AEC-tr–7303) RADIOBIOLOGY, VOL. 11, NO. 3, 1971. Translation of Radiobiologiya; 11: No. 3, 323-480(May-Jun 1971). 228p. Dep. NTIS.

Separate abstracts were prepared for 32 of the 33 papers appearing in this translation. The other paper discusses the effects of radioprotective compounds and radiosensitizers on the level of protein sulfhydryl groups in mouse spleen lymphocytes. (E.R.B.)

For abstracts of individual papers see: 33567–33570, 33600–33603, 33618–33622, 33645–33648, 33704–33714, 33777, 33794, 33805, and 33821.

33704 (AEC-tr-7303, pp 42-50) INCORPORATION OF ^{14}C-PHENYLALANINE INTO THE PROTEIN FRACTIONS OF ISOLATED NUCLEI OF CERTAIN TISSUES OF HEALTHY AND IRRADIATED RATS. Blokhina, V. D.; Mikhaylova, L. P.; Nikol'skii, A. V.; Romantsev, E. F. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 3, 351-6(May-Jun 1971).

The incorporation of ^{14}C-phenylalanine into eight protein fractions of thymus, spleen, and liver nuclei of healthy and irradiated (1000 R) rats was studied under conditions of incubation of the nuclei in vitro; the percent composition of the protein fractions, as well as the absolute content of protein, DNA, and RNA in them, were studied. It was shown that 24 hrs after irradiation, the content of protein, DNA, and RNA in the acid protein and in the thymus and spleen histones is reduced. The percent composition of the protein fractions of the nuclei of the three tissues studied is negligibly changed, with some tendency for an increase in the soluble proteins and a decrease in the histone fraction. The incorporation of ^{14}C-phenylalanine into the protein fractions of the thymus and spleen nuclei is sharply inhibited, an effect that is especially pronounced in the histone fraction. In the liver, the incorporation of ^{14}C-amino acid into the total protein of the nuclei is increased on account of a substantial increase in the synthesis of residual and acid protein. (tr-auth)

33705 (AEC-tr-7303, pp 57-62) INFLUENCE OF THERAPEUTIC ADMINISTRATION OF DNA ON THE MORPHOLOGICAL CHANGES IN THE EPITHELIUM OF THE SMALL INTESTINE OF RATS AFTER 1600 R OF γ IRRADIATION. Revina, V. S.; Lemberg, V. K. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 11: No. 3, 362-6(May-Jun 1971).

The cellular composition of the epithelium of the rat duodenum was studied after whole-body γ irradiation in a dose of 1600 R, followed by a single intraperitoneal injection of a high-polymer preparation of homologous DNA (0.025 mg/g). It was shown that the therapeutic administration of DNA, without changing the degree of expression of destructive processes in the early periods after irradiation, appreciably intensifies the recovering reproductive activity of the cells of the crypts, and as a result of this reduces the intensity of loss of the entire population of the epithelium of the small intestine. (tr-auth)

33706 (AEC-tr–7303, pp 63-70) PERMEABILITY OF THE VESSELS AFTER THE ACTION OF PENETRATING RADIATION ON THE ORGANISM. Oyvin, I. A.; Gumenyuk, L. I.; Gaponyuk, P. Ya.; Tokarev, O. Yu.; Volodin, V. M. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 3, 367-71(May-Jun 1971).

The permeability of the vessels of the body was studied in rabbits and rats at various periods after whole-body γ irradiation at the doses $LD_{75-100/30}$. The state of permeability of the vessels was evaluated according to the deposition of India ink particles in them (histological and biomicroscopic investigation) and that of ^{198}Au (radiometric determinations). No regular and generalized increase in the permeability of the vessels was detected. The discrepancy of the results from the literature data is explained by the use of inadequate methods in the preceding studies, in which the acceleration of the transvascular transport of substances was explained by an increase in the permeability of the vessels, i.e., by a breakdown of their structure, and not by changes in the hemodynamics, arising during the development of radiation sickness. (tr-auth)

33707 (AEC-tr–7303, pp 71-8) STATE OF THE CONDITIONED REFLEX ACTIVITY OF DOGS DURING CHRONIC γ IRRADIATION. Sizan, E. P.; Markelov, B. A. Translated from Radiobiologiya; 11: No. 3, 372-7(May-Jun 1971).

Great sensitivity of chain motor conditioned reflexes in dogs during their reinforcement to continuous low-power γ irradiation with ^{60}Co was detected. The total average tissue absorbed dose was 125 rad per year. The ability of the nervous system to compensate for changes in the conditioned reflexes in the presence of continuing irradiation was demonstrated. The influence of radiation over a 3-yr period led to a decrease in the excitation process and a deepening of inhibition. (tr-auth)

33708 (AEC-tr–7303, pp 79-85) CHANGE IN THE NUCLEIC ACID METABOLISM IN THE SPLEENS OF IRRADIATED ANIMALS UNDER CONDITIONS OF CHEMICAL PROTECTION. D'yachenko, A. G.; Dikovenko, E. A. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Translated from Radiobiologiya; 11: No. 3, 378-82(May-Jun 1971).

The influence of 5-methoxytryptamine on the DNA metabolism and that of various RNA fractions of the spleen was studied in mice irradiated at a dose of 800 R. The protective influence of the protector on RNA biosynthesis, especially that of messenger RNA (RNA-65°), was already detected 2 hrs after irradiation. The level of incorporation of ^{32}P into DNA exceeded the control 24 and 72 hrs after irradiation. In intact mice, 5-methoxytryptamine had no appreciable influence on the nucleic acid biosynthesis, but it reduced the penetration of the label into the acid-soluble fraction of the spleen tissue. (tr-auth)

33709 (AEC-tr–7303, pp 92-8) EARLY CHANGES IN THE SEROTONIN CONTENT IN THE ORGANS UNDER THE INFLUENCE OF RADIOPROTECTORS AND IRRADIATION. Kulinskii, V. I.; Parunov, V. A. (Ukrainian Inst. for the Advanced Training of Physicians, Kharkov). Translated from Radiobiologiya; 11: No. 3, 387-91(May-Jun 1971).

In the early periods after irradiation in a number of organs of mice there is a decrease in the content of serotonin (S), which is evidence of its mobilization. Radioprotectors (RP) release S from the intestines and increase its content in the spleen, cerebrum, and brain stem. Probably, in the spleen, the accumulation of S from the blood flow is increased, while in the brain, biosynthesis is enhanced. Under the joint influence of cystamine (CA) and irradiation, the early mobilization of S in the spleen, lungs, heart, and brain stem is more pronounced than under irradiation alone. The data obtained are evidence of the significance of endogenous S for radioresistance. (tr-auth)

33710 (AEC-tr—7303, pp 175-7) INFLUENCE OF FORMALDEHYDE ON THE RADIOSENSITIVITY OF WHITE MICE. Kolesnikov, P. A.; Tiunov, L. A.; Ivanova, L. V. Translated from Radiobiologiya; 11: No. 3, 446-8(May-Jun 1971).

It was shown that in the case of inhalation influence, formaldehyde increases the radiosensitivity of white mice to subsequent x irradiation. A decrease in the level of sulfhydryl groups in the blood of the animals was recorded simultaneously. The results are discussed in the light of the hypothesis of a leading role of endogenous thiols in the formation of radiosensitivity. (tr-auth)

33711 (AEC-tr—7303, pp 178-81) CONTENT OF CATECHOLAMINES IN THE ORGANS OF UNPROTECTED AND CYSTAMINE-PROTECTED MICE IN THE EARLY PERIODS AFTER WHOLE-BODY X IRRADIATION. Miller, L. P. (Ukrainian Inst. for the Advanced Training of Physicians, Kharkov. Second City Clinical Hospital, Kharkov). Translated from Radiobiologiya; 11: No. 3, 448-50(May-Jun 1971).

A liberation of catecholamines from depots and their conversion to an active form was detected in experiments on mice in the early periods after whole-body x irradiation (806 rad). In radiovulnerable tissues — spleen, small intestine, and adrenals — the decrease in the catecholamine content was more pronounced than in other organs. In mice protected by cystamine, irradiation produced greater mobilization of catecholamines than in unprotected mice. The possible significance of early mobilization of catecholamines in the natural radioresistance is discussed. (tr-auth)

33712 (AEC-tr—7303, pp 182-7) SECRETORY FUNCTION OF THE KIDNEYS AFTER X IRRADIATION AND PROPHYLACTIC ADMINISTRATION OF CYSTAMINE. Bryukhanov, V. M. (Altay Medical Inst., Barnaul, USSR). Translated from Radiobiologiya; 11: No. 3, 451-4(May-Jun 1971).

Whole-body x irradiation of rabbits at doses of 1100 and 1600 R inhibited the secretory activity of the kidney tubule epithelium in rabbits. The use of cystamine before irradiation (100 mg/kg of weight intravenously) did not have any appreciable influence on the renal secretion. (tr-auth)

33713 (AEC-tr—7303, pp 188-92) INFLUENCE OF PRELIMINARY IRRADIATION ON THE RADIOPROTECTIVE EFFECT OF CYSTAMINE. Smirnov, A. D.; Antipenko, E. N.; Pyatovskaya, N. N. (Kirov Military-Medical Academy, Leningrad). Translated from Radiobiologiya; 11: No. 3, 454-8(May-Jun 1971).

Preliminary irradiation of rats at a dose of 100 R has different influences on the ability of cystamine to reduce the postmitotic death of cells in various hematogenic tissues under the subsequent influence of radiation at a dose of 50 R (interval between irradiations 3 days): in the bone marrow the radioprotective influence of cystamine is increased, while in the lymph nodes it is unchanged. The radioprotective effect with respect to interphase death of the cells is not present in either tissue under these conditions, just as in the case of a single irradiation at a dose of 50 R. (tr-auth)

33714 (AEC-tr—7303, pp 193-6) CHANGE IN THE FUNCTIONAL PROPERTIES OF THE GRANULOCYTES UNDER THE INFLUENCE OF X IRRADIATION. Koroleva, L. V. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 11: No. 3, 458-60(May-Jun 1971).

A change in the functional properties of the leukocytes isolated from a peritoneal exudate of the animals was detected in experiments with x irradiation of rabbits and rats. The granulocytes of the irradiated animals possessed less pronounced leukotaxic activity and in the case of intracutaneous injections produced a smaller increase in the permeability of the vessels of the skin in comparison with the leukocytes of intact animals. (tr-auth)

33715 (CNAEM—55) TOTAL IRRADIATION AND THYMUS. Yegin, M. Muenip (Cekmece Nuclear Research Center, Istanbul (Turkey)). Jul 1968. 10p. (In Turkish). Dep. NTIS (U. S. Sales Only).

Male and female albino rats were irradiated at 1000 mrem. Their thymus glands were removed after irradiation at different times ranging from 0.5 hour to six days. The weight decrease of the gland was found to be 94% when the operation was performed on 6th day after the irradiation. It was observed that the decrease in the weight of thymus depends on the sex during the first three hours after irradiation, and becomes independent of the sex, starting from the 4th hour. (Key Turk. Sci., Chem.)

33716 (ORO—3634-14) INVESTIGATION OF ALLOGRAFT REJECTION. V. STUDIES OF DEFINED HISTOCOMPATIBILITY SYSTEMS. Progress Report, August 1, 1971—July 31, 1972. De Angelis, W. J.; Haughton, Geoffrey (North Carolina Univ., Chapel Hill. Dept. of Bacteriology and Immunology). 17 Apr 1972. Contract AT(40-1)-3634. 6p. Dep. NTIS.

It was shown that macrophages labeled with gold-198 and transplanted intraperitoneally are eliminated more rapidly from the peritoneum of H-2-incompatible recipient mice than from syngeneic recipients. Following elimination, label accumulates in the liver. The ratio of radioactivity present in the peritoneum to radioactivity present in the liver, plotted against time after transplantation, gives a straight line, and the slope is directly related to the strength of the histocompatibility barrier crossed. This elimination from the peritoneum is a consequence of recognition of, and reaction by the host against the graft, and not vice-versa. Cells transferred from parent to F_1 hybrid behave very much like syngeneic, but cells from F_1 hybrid transferred into either parent migrate from the peritoneal cavity as the allogeneic cells do. Irradiation of the host before transfer prevents or reduces migration rate, but irradiation of the donors neither prevents elimination by allogeneic hosts nor hastens elimination by syngeneic hosts. A double transfer system was developed to measure rejection across H-2 histocompatibilities. By this means it is possible to distinguish between different H-2 barriers indistinguishable by any other means. The "reversal" system outlined has been applied to a study of reaction against H-Y antigens, the histocompatibility antigen present in males but absent in females of the same inbred strain. It was found that the speed of rejection varies between strains and is correlated with the allele carried at the H-2 locus. (auth)

33717 EXTENDED RECOVERY LAG IN RAT HEMATOPOIETIC COLONY FORMING UNITS FOLLOWING SUBLETHAL X-IRRADIATION. Okunewick, James P.; Phillips, Eleanore L. (Allegheny General Hospital, Pittsburhg). Contract AT(30-1)-4205. J. Lab. Clin. Med.; 79: No. 4, 550-8(Apr 1972).

Experiments have been performed to evaluate the rate of recovery of the transplantable marrow CFU (colony-forming unit) compartment in the sublethally irradiated rat. It was found exposure to 200 R x-irradiation reduced the number of transplantable femoral CFU's to a value of less than 25 percent of normal. This reduction was sustained for a period in excess of 9 days after irradiation. In contrast, the number of total nucleated marrow cells had regained normal levels by the fifth day following irradiation. The data has been compared with the results in both the rat and the mouse reported by other investigators studying the suppression and recovery of the erythropoietin-responsive compartment after sublethal x-ray exposure. It is noted that, similar to the findings for total nucleated marrow cells, recovery of erythropoietin response also begins at a much earlier time than does the recovery of colony-forming units. It is suggested that different control mechanisms govern the rate of recovery of these 2 compartments. (auth)

33718 COMBINED FETAL LIVER AND THYMUS FOR HEMATOPOIETIC RECONSTITUTION OF ALLOGENEIC RADIATION CHIMERAS. Giller, Roger H.; Bortin, Mortimer M.; Rimm, Alfred A.; Glasspiegel, John S.; Saltzstein, Edward C. (Mount Sinai Medical Center, Milwaukee. Medical Coll. of Wisconsin, Milwaukee). Proc. Soc. Exp. Biol. Med.; 139: No. 3, 1022-7(Mar 1972).

Femoral bone marrow cellularity, CFU concentration, and CFU content were markedly subnormal in allogeneic radiation chimeras that had been produced with bone marrow cells from adult donors. Marrow cellularity was restored to normal within 3 weeks when liver or liver plus thymus from fetal donors was the tissue transplanted. In chimeras produced with fetal cell transplants, marrow CFU increased at a slower rate than did differentiated marrow cells. However, at 77 ± 7 days, chimeras produced with fetal liver plus fetal thymus cells had normal numbers of femoral CFU and this level was significantly higher than in chimeras produced with fetal liver without thymus cells. Hematopoietic repopulation of allogeneic radiation chimeras using combined fetal liver and thymus cell transplants was equal or superior to that achieved with fetal liver alone or adult bone marrow despite the fact that with the latter tissues 2 to 5 times as many hematopoietic stem cells had been transplanted. (auth)

33719 COMPETITIVE IN VIVO PROLIFERATION OF FOETAL AND ADULT HAEMATOPOIETIC CELLS IN LETHALLY IRRADIATED MICE. Micklem, H. S. (Univ. of Edinburgh); Ford, C. E.; Evans, E. P.; Ogden, D. A.; Papworth, D. S. J. Cell. Physiol.; 79: No. 2, 293-8(Apr 1972).

The relative proliferative capacity of haematopoietic cell populations derived from 22-week-old adult bone marrow and 14 to 18 day foetal liver has been studied in lethally irradiated syngeneic recipients by means of chromosome markers. Although starting at a disadvantage in terms of the number of colony-forming units (stem cells) injected, the foetal liver-derived populations steadily increased their relative numbers in the myeloid and lymphoid tissues over a period of several weeks until a plateau was reached. It is suggested that stem cells in foetal liver have, on average, a higher intrinsic capacity for self-renewal than do those in bone marrow, and that this capacity falls to the adult level within about ten weeks of transfer. (auth)

33720 EFFECT OF X-RAYS UPON THE BIOELECTRICAL ACTIVITY OF THE SMOOTH MUSCLE OF THE CAT'S STOMACH. Lukanow, J.; Boew, K.; Papasowa, M. (Inst. for Physiology, Sofia). Stud. Biophys.; 28: No. 1, 49-55(1971). (In German).

The effect of x rays on the bioelectrical activity of the cat's stomach with respect to gastric motility was studied. Tests were carried out in vitro on 30 animals divided into three groups according to the dose of x-ray treatment (up to 400 R, from 700 to 1000 R, and from 3000 to 7000 R). Two kinds of typical variations in the pattern of bioelectrical activity were found, dependent on the dose of the x-ray treatment. On treatment with a dose of 400 R, variations of a group type were predominant (periodic desynchronization of the simultaneous rhythm of the stomach). In case of x-ray treatment with over 1000 R, each part of the stomach generated slow potentials of specific frequency. The slow potentials very frequently spread in the opposite direction, i.e., antiperistaltically. There is evidence to suggest that the changes in the bioelectrical activity provoked by small doses of x-ray treatment result mainly from the injuries to the intramural innervation of the stomach. With a dose over 1000 R, the smooth-muscle cell is injured also. (auth)

33721 INJURY TO INTESTINE DURING INTERNAL AND EXTERNAL IRRADIATION. Ponomareva, T. V. (Inst. of Radiation Hygiene, Leningrad). Arkh. Anat., Gistol. Embriol.; 59: No. 9, 69-75(Sep 1970). (In Russian).

Three groups of white rats were exposed to radiation. In group 1 mixed radioactive isotopes in a 500 μCi/rat dose were administered to the stomach. Group 2 was exposed to external gamma radiation at 300 R dosage. In group 3 the animals were exposed to combined external and internal irradiation. Peyer's patches, lymphocytes in epithelium and basement membrane of small bowel mucosa were examined in control and experimental animals. Lymphoid tissue proved to be affected with the greatest severity in animals exposed to combined irradiation. After internal, in contrast to external, irradiated lymphoid tissue injury proved to be distributed unevenly. Tissues nearest to intestinal lumen were more severely injured. There was mass extrusion of lymphocytes into intestinal lumen. Radiation-sensitive and radiation-resistant forms of small lymphocytes were separated spacially, occupying distinct areas of intestinal mucosa and Peyer's patches. (auth)

33722 DEPENDENCE OF ACTIVITY OF DEHYDROGENASES IN IRRADIATED ANIMALS ON THE GLUCOCORTICOID LEVEL. Tsykhun, G. F. (Inst. of Physics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 6, 95-8(1971). (In Belorussian).

Data are presented on the effect of whole-body x irradiation (40 R) on the change in activity of dehydrogenase of mitochondria of mouse heart. A shift in the intensity of the oxidation-reduction processes in the myocardium, in particular the activity of dehydrogenases of α-ketoglutaric, pyruvic, and malic acids, under the effect of relatively small doses of x radiation was found to be associated primarily with reactions of the adrenal system and the glucocorticoid level. (tr-auth)

33723 EFFECTS OF WHOLE-BODY IRRADIATION ON METABOLISM IN RATS. Scoppa, P. (CCR-EURATOM, Ispra, Italy). Minerva Fisiconucl.; 15: No. 2, 77-80(Apr-Jun 1971). (In Italian).

Exposure to ionizing radiations may alter the biological response to several chemical compounds with therapeutic or toxic action. In vivo and in vitro experiments have shown that sublethal whole-body x irradiation does not result in primary effects on the metabolism of foreign compounds in adult rats. Metabolic alterations observed in vivo have to be considered as secondary effects, related to radiation induced modifications of hormonal equilibrium. (auth)

33724 REGULATION OF HAEMOPOIETIC STEM CELL TURNOVER IN PARTIALLY IRRADIATED MICE. Gidali, Julia; Lajtha, L. G. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Cell Tissue Kinet.; 5: No. 2, 147-57(Mar 1972).

The existence of a possible local control of CFU turnover was studied in mice in which one tibia only was irradiated (LR mice) and in mice in which one tibia was shielded during whole-body irradiation (TBR mice). In both the LR and TBR mice, the increased CFU turnover continued in the irradiated tibiae even after the time when in the unirradiated (shielded) tibiae it returned to normal levels. The early temporary decrease in the CFU numbers in the shielded tibiae of TBR mice is attributed to a temporary demand for increased differentiation rather than to migration of CFU. The direct control of CFU turnover appears to be local in nature, in contrast to the stimulus for CFU differentiation. (auth)

33725 RELATION BETWEEN THE LEVEL OF SEROTONIN IN THE BLOOD AND INTESTINE ON THE ACTIVITY OF XIII FACTOR IN ACUTE RADIATION SICKNESS. Ponomarev, Yu. T.; Dorofeev, V. M. (Scientific Research-Inst. of Medical Radiology, Obninsk, USSR). Byull. Eksp. Biol. Med.; 73: No. 2, 44-6(Feb 1972). (In Russian).

During acute radiation sickness Wistar rats were subjected to intravenous injection of XIII factor and other plasma components obtained with the aid of gel-filtration of plasma of healthy animals through Sefadex G-200 (40 protein/kg of body weight). Transfusion of XIII factor caused a rise in the level of serotonin in the blood and duodenum, increased the vascular resistance, normalized the bleeding time and volume of lost blood. Other plasma components did not exert such an effect. (auth)

33726 RESERVE OF RED BLOOD CELLS IN HEALTHY AND CHRONICALLY IRRADIATED DOGS. Ilyukhin, A. V.; Semashko, L. L.; Izergina, A. G.; Markelov, B. A. Kosm. Biol. Med.; 6: No. 2, 21-3(Mar-Apr 1972). (In Russian).

Experimental data are presented which help to quantitate the degree at which the reserve of red blood cells of healthy and irradiated dogs is mobilized after a physical stress. Following a 15-min. running in the treadmill at a speed of 5.2 km/hour, healthy dogs release into the blood flow 2.5 ± 0.9% of red blood cells from the total amount of cells circulating in the blood. The most distinct index showing the state of the red blood cell reserve is reticulocytosis which develops in response to an assigned physical load. It is suggested that the reserve of red blood cells originates in the bone marrow. No significant differences in the quantitative reserve of red blood cells of healthy and irradiated dogs have been found. The animals were irradiated with total doses of 370, 565, 670 and 770 rads for 24, 36, 42 and 51 months, respectively. (auth)

33727 STATE OF NATURAL IMMUNITY OF DOGS DURING CHRONIC GAMMA-IRRADIATION UNDER THE INFLUENCE OF AMITETRAVITE. Pal'mina, S. I.; Zueva, V. A.; Gvozdeva, N. I.; (and others). Kosm. Biol. Med.; 6: No. 2, 24-9(Mar-Apr 1972). (In Russian).

The effect of amitetravite, a biological protectant, on the state of natural immunity was investigated in experiments on dogs exposed to a three-year chronic gamma-irradiation simulating the dose value and rate of the space flight environment. A long-term irradiation of dogs with low dosages of ^{60}Co gamma-rays induced wave-like changes in natural immunity of test animals. A regular administration of amitetravite produced a normalizing effect on the state of skin autoflora, favored a relative stability of indices of the blood phagocytic activity and restrained the development of autoimmune reactions. (auth)

33728 NOVEL ASPECT OF THE RESPONSE OF THE CENTRAL NERVOUS SYSTEM TO IRRADIATION: THE PEROXIDASE-POSITIVE GLIA. Srebro, Z.; Lach, H.; Szirmai, E. (Inst. of Biomorphology, Krakow. Teacher Training Coll., Krakow. Inst. of Nuclear Engineering, London. Inst. of Nuclear Engineering, Stuttgart). Radiat. Res.; 50: No. 1, 65-72(Apr 1972).

The brains of x-irradiated and repeatedly uv-irradiated rats and mice show a considerable increase in number of periventricular glial cells which contain copious granular material rich in thiol groups. Electron-microscopically this material is composed of dense bodies showing peroxidase activity. The appearance of the thiol-rich peroxisome-like organelles in the periventricular glial cells during the postirradiation period is interpreted as a reaction to circulating radiotoxins of organic peroxide type. (auth)

33729 EFFECT OF RADIATION UPON THE EMBRYONIC THYMUS. Swasdikul, Daratana; Block, Matthew (Univ. of Colorado, Denver). Radiat. Res.; 50: No. 1, 73-84(Apr 1972).

The effect of a MLD of total body irradiation on the embryonic thymus of the opossum was analyzed. The destructive effect depended on cell types in the thymus when irradiated. Small lymphocytes immediately after formation were more sensitive to irradiation than older small lymphocytes. Hassall's corpuscles and epithelial cells were most resistant to the destructive effect of irradiation. Mitoses were most suppressed at 16 hours after irradiation. The suppressive effect was greatest when the thymus was filled with small lymphocytes at the time of irradiation. Embryos irradiated when the mitotic index was highest had an elevated mitotic index. Irradiation of epithelial thymus delayed first appearance of lymphocytes about 2 days. The sequence of appearance of lymphocytes in the embryonic thymus after irradiation recapitulated normal embryogenesis. Regeneration of lymphocytes in older embryos was modified because of the persistence of small lymphocytes after irradiation. These cells eventually disappeared and the thymus subsequently regenerated as though starting from an epithelial sheet, so also simulating normal embryonic development. The closer irradiation is given to the time of normal appearance of Hassall's corpuscles, the greater the delay in their subsequent appearance. Regeneration from irradiation in embryo recapitulates normal embryology as the latter recapitulates phylogeny. (auth)

33730 EFFECT OF ATP ON THE DEVELOPMENT OF POST-IRRADIATION CHANGES IN THE RAT. Zyss, Ryszard; Gajkowska, Barbara; Michalska-Kaszynska, Maria. Patol. Pol.; 22: No. 2, 305-21(Apr-Jun 1971). (In Polish).

Oxidative phosphorylation is known to be closely connected with the structure of mitochondria. X-irradiation quickly dissociates and inhibits oxidative phosphorylation and damages the structure of mitochondria. The normal course of processes of oxidative phosphorylation is dependent on appropriate concentrations of adenosinetriphosphate (ATP). Changes in the content of this compound influence the structure of mitochondria (edema, contraction). These facts suggested that postradiation lesions in cells may be due to changes in ATP content. Experiments were therefore performed to ascertain whether administration of ATP exerts an appreciable effect on the post-radiation lesions in liver cells of rats irradiated with 1000 R. ATP was administered in doses of 100 mg/ml one hour before irradiation and in the course of 1 to 10 days after irradiation. Changes in cell structures (mainly mitochondria) and histo- and cytochemical reactions for nucleic acids, glycogen, lipids, SDH and ATPase activities were observed. Administration of ATP protected the liver cells from the effects of radiation. Changes in mitochondrial structure and in the contents of nucleic acids, glycogen and lipids appeared later (5 to 7 days after irradiation), were much less intensive, and involved a smaller number of cells in the liver lobules. The histo- and cytochemical reactions for SDH and ATPase showed virtually no difference from the controls throughout the period of observation. (auth)

33731 FATE OF DNA-LABELLED BONE-MARROW CELLS FROM DIFFERENT MOUSE STRAINS INJECTED INTO SYNGENEIC IRRADIATED RECIPIENTS. Gerber, G. B.; Decleve, A.; Maisin, J. R.; Leonard, A.; Mattelin, Gh. (CEN/SCK, Mol, Belgium). Experientia; 28: No. 2, 149-51(15 Feb 1972).

Three strains of donor mice were injected with ^{3}H-6-thymidine 12 and 24 hr before sacrifice. Recipient mice were whole-body x-irradiated with a dose of 650 R and were given intravenous injections of nucleated cells from the femur of the donors. At intervals after injection the recipients were killed, and the spleen, thymus, and femoral marrow were removed. The DNA content of these organs was determined and values are tabulated. Data on total and specific activity of the three organs are shown by means of graphs. Highest activities were found in the spleen and lowest in the bone marrow. The decline in specific activity was also most pronounced in the spleen and only slight or absent in the thymus. (H.L.W.)

33732 MECHANISM OF DELAYED HYDROCEPHALUS INDUCED IN MICE EXPOSED TO X-RADIATION IN THE UTERUS. Kameyama, Yoshiro; Hoshino, Kiyoshi (Nagoya Univ., Japan). Nagoya Daigaku Kankyo Igaku Kenkyusho Nempo; 22: 212-14 (Mar 1970). (In Japanese).

In order to study the mechanism of the incidence of delayed hydrocephalus which occurs most frequently in mice irradiated on their thirteenth gestational day, x-radiation in a single dose of 200 R was given to CF 1 mice at 12 to 17 days of pregnancy and an observation was made of the postnatal development of the brain in newborn mice. No obstruction in the cerebrospinal circulation was observed in delayed hydrocephalus in the present experiment. Venous circulatory disorders in the subendymal white matter of the paracoele and the secondary degeneration of the brain parenchyma prior to the rapid expansion of the cerebral ventricles in one to two weeks after birth were observed. Furthermore, considerable congestion was demonstrated in the lateral plexus, suggesting abnormal secretion of cerebrospinal fluid. From the relationship between the incidence of hydrocephalus and cerebral circulatory disorders with respect to time and anatomical concern, it was concluded that the cause of this disease would be regressive degeneration of the brain parenchyma and the excessive secretion of cerebrospinal fluid due to the circulatory disorders of the Galen's vein system located in the depth of the brain parenchyma. (Japan)

33733 RADIOPROTECTIVE EFFECTIVENESS OF SOME SEROTONIN-LIKE COMPOUNDS. Deanovic, Z.; Pericic, D.; Supek, Z. (Inst. Rudjer Boskovic, Zagreb). Experientia; 27: No. 12, 1448-9(15 Dec 1971).

Five groups of 20 mice each were given a supralethal dose (1400 R) of x radiation. Five to ten minutes before irradiation intraperitoneal injections of the following compounds were given: 5-ethoxytryptamine, 5-methoxytryptamine, 5-hydroxytryptamine, 3-(β-aminoethyl)-5-hydroxy-benzo(b)thiophen (SAS), and 5-methoxy-SAS. The survival of the animals was followed for 30 days. The results indicated that 5-ethoxytryptamine and SAS were protective to the same extent. The effectiveness was slightly lower than that of 5-methoxy-tryptamine. No radioprotective effect was found for 5-methoxy-SAS. (H.L.W.)

33734 EFFECTS OF RADIATION DOSES ON THE INCIDENCE TIME OF CATARACT IN THE RABBIT. DETERMINATION OF THE RBE VALUES OF 14 MeV NEUTRONS. Haye, C.; Legeay, G.; Bazin, J. P.; Quechon, H. (CEN, Fontenay-aux-Roses, France). Ann. Ocul. (Paris); 203: No. 8, 749-67(1970).

The relative biological effectiveness for the cataractogenic effect of 14 MeV monoenergetic neutrons was studied in the rabbit. The criteria for lens opacification corresponded to well established clinical stages, which made it possible to study the response functions, taking into account both absorbed doses and the mean incidence times of latency for the several stages of cataract to appear. The graphs demonstrated an induction threshold for the incidence time at high doses; for the intervals in which the incidence time was a function of dose, it was possible to determine the RBE values as a function of the stage by comparison with the reference γ rays. (France)

33735 EFFECTS OF X-RADIATION ON SALIVARY GLAND GROWTH IN THE RAT. III. RELATIVE EFFECTS OF LOCAL IRRADIATION ON WET WEIGHT, PROTEIN, AND NUCLEIC ACIDS OF THE SALIVARY GLAND DURING POST-NATAL GROWTH AND SECRETION AND RESYNTHESIS OF PAROTID AMYLASE. van den Brenk, H. A. S.; Stone, M. G. (St. Thomas' Hospital, London). Int. J. Radiat. Biol.; 21: No. 3, 247-56(Mar 1972).

Changes occurring in wet weight, total protein, RNA and DNA of the submandibular salivary gland (SMG) in the rat during postnatal development are described. During gland growth, the ratio DNA/protein increased initially at a less rapid rate than RNA/protein; subsequently, after onset of sexual maturity, both ratios declined, DNA/protein decreasing somewhat earlier. Dose-effect curves for growth of gland after x-irradiation with a single dose, measured in terms of wet weight, total protein, RNA and DNA differed in slope and shape but showed that increase in content of RNA and DNA resulting from gland growth was most radiosensitive and appeared to be largely associated with cell replication. Growth measured in terms of increases in wet weight or total protein was more radioresistant, and protein synthesis appeared to be more closely associated with auxetic cell growth and with cell maturation and differentiation during development. Further evidence that synthesis of acinar protein by salivary tissues is resistant to radiation was shown by the lack of effect of a large single dose (1200 rads) of x-radiation applied locally on the secretion and resynthesis of amylase by the parotid gland in the rat. (UK)

33736 IMMUNOLOGICAL TOLERANCE AND ITS INTERRUPTION BY DIFFERENT RADIATION DOSES. Orbach-Arbouys, Simone; Lecocq, Chantal (Hospital Paul-Brousse, Villejuif, France). Z. Immunitaetsforsch. Exp. Klin. Immunol.; 143: No. 1, 1-5(Jan 1972). (In French).

A large dose of x radiation destroyed immune tolerance to sheep red blood cells in a greater number of rats than a weak dose of radiation. Tolerance induced by 16 injections of tolerogen was more difficult to destroy than tolerance induced by fewer injections. A more or less pronounced form of tolerance was established. (H.L.W.)

33737 INFLUENCE OF FRACTIONATED X-IRRADIATION ON THE DEVELOPMENT OF PALATE CLEFTS IN MOUSE EMBRYOS. Grigorow, Luben (Staatliche Zentrale fuer Strahlenschutz, Berlin). Stud. Biophys.; 28: No. 2, 85-98(1971). (In German).

The development of palate clefts after irradiation of mouse embryos (ALH) on the 11.5th day of gestation was investigated. No palate clefts could be observed after an exposure with less than 148 R. Increasing the dose causes an increased development of palate clefts. After fractionated irradiation with intervals of less than 60 minutes no significant differences were observed in the development of palate clefts in comparison with a single irradiation with the same total dose (250 R). Fractionated irradiation with intervals of 3 to 30 hours causes a lower rate of malformation than a single irradiation. (auth)

33738 EXPERIMENTAL INTESTINAL MALABSORPTION STATES AND THEIR RELATION TO CLINICAL SYNDROMES. Robinson, J. W. L. (Univ., Lausanne, Switzerland). Klin. Wochensch.; 50: No. 4, 173-85(15 Feb 1972).

The literature pertaining to experimental malabsorption syndromes induced in laboratory animals is reviewed and the relationships between these syndromes and human malabsorption are discussed. Particular attention is paid to functional studies and to relationships between structure and function. The syndromes discussed include the effect of anti-mitotic drugs, including colchicine (which may have a distinct inhibitory effect on intestinal disaccharidases and therefore provide a mode for disaccharide intolerance); the effect of ionising radiation; intestinal damage from triparanol, and its relationship to human gluten enteropathy; the response of the intestine to ischaemia and shock; and finally the effect of neomycin, a drug that has provoked symptoms of malabsorption in man which have never been satisfactorily explained nor reproduced in animal studies. (auth)

33739 RADIOINDUCED IMMUNE EFFECTS. Sandru, Gh.; Costachel, O. Oncol. Radiol.; 10: No. 3, 265-72(1971). (In Rumanian).

Immune reactions of mice and rats to irradiated skin and tumor grafts were studied. Jensen and Guerin tumors, epitheliomas, and hemocytoblastomas were irradiated in vitro. It was found that rats that resorbed the irradiated tumor graft became resistant to a new graft of the same type. Observations are reported on radioinduced immunosuppression in rats, development of pulmonary metastases, rejection time of allogeneic skin grafts, and role of immunologic factors in manifestation of radioinduced lethal injuries. (H.L.W.)

33740 EFFECT OF X IRRADIATION ON THE LEVELS OF SOME SULFHYDRYL GROUPS, PROTEIN, AND CELL VOLUME OF EHRLICH ASCITES TUMOR CELLS. Yu, Choon Shik; Choo, Young Eun. Taehan Saengri Hakhoe Chi; 3: No. 2, 77-84(1969). (In Korean).

It is well known that a number of -SH and -SS containing substances afford a certain measure of protection against radiation effects in many biological systems, and it is conceivable that inherent -SH levels in Ehrlich ascites tumor (ELD) cells may be of decisive importance with respect to the development of cellular radiation injury. So far, little effort has been directed to elucidate the changes in levels of different -SH and -SS groups in ELD cells when the tumor-bearing whole animal was subjected to the sublethal dose of x-irradiation. The present study was designed to bring some light on the possible changes of and relationship between various sulfhydryl levels, such as P-SH and NP-SS, as well as the content of protein and cell volume of ELD cells, after subjecting the ELD mice to 1,200 R of x-irradiation. (Korean Sci. Abstr.)

33741 EFFECT OF X-IRRADIATION ON THE OXYGEN CONSUMPTION RATE AND PROTEIN LEVEL OF EHRLICH ASCITES TUMOR-BEARING MOUSE LIVER AND KIDNEY. Choi, Byung Ok; Choo, Young Eun. Taehan Saengri Hakhoe Chi; 3: No. 2, 85-91(1969). (In Korean).

Oxygen consumption rate (QO_2) and protein content of liver and kidney of the Ehrlich ascites tumor-bearing mouse were measured from the 6th to 14th day after the inoculation of 4×10^6 Ehrlich ascites tumor cells. The results thus obtained were compared with those of the groups in which whole body x-irradiation with 400 R was given to mice prior to the inoculation of 4×10^6 Ehrlich ascites tumor cells, the same number of the irradiated tumor cells were inoculated after subjecting the tumor cells to x-irradiation with 400 R or 900 R in vitro, and the normal. (Korean Sci. Abstr.)

33742 AGING AND ITS GENETICS. Sharma, Archana (Univ. of Calcutta). Sci. Cult. (Calcutta); 37: No. 6, 274-9(Jun 1971).

A general discussion is presented of age changes in organisms and of general theories of aging. A discussion of genetic theories of aging emphasizes the role of germ cells and somatic mutations in aging. The use of radiation as a tool in research on aging is discussed and a brief review is presented on the use of radiation for simulating age effects in animals. When young mice were irradiated they showed no apparent injury but after a time they aged very rapidly and died much earlier than controls. Cytological studies on regenerating cells of mouse liver demonstrated a relationship between chromosome aberrations and radioinduced life shortening. Studies on Drosophila, plants, and other organisms indicated that aging is dependent on chromosome stability. Other studies supporting a somatic mutation theory of aging are reviewed; objections to this theory are also pointed out, the most relevant being that treatment with chemical mutagens does not produce life shortening. Plans for future research on aging are briefly discussed. (H.L.W.)

33743 RELATIVE BIOLOGICAL EFFECTIVENESS OF HIGH-ENERGY BREMSSTRAHLUNG IN THE GeV RANGE. Kuenkel, H. A.; Zywietz, F. (Univ., Hamburg). pp 217-27 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Radiobiological investigations on various objects (mice, seeds of Vicia faba, Drosophila, E. coli and solutions of DNA) carried out at the Deutsches Elektronen-Synchrotron (DESY) with high-energy x rays (from 3 to 7 GeV) are reported. Dosimetry (chemical dosimetry, ionization- and quantum-flux-measurements) and irradiation techniques are described. The build-up effect was measured in a 150-cm water-phantom. The first biological experiments were carried out on dry seeds of Vicia faba. Later on, the root-tip meristem of 3-d-old seedlings was exposed to various doses of high-energy photons of 3 or 6 GeV, respectively. In all these experiments an RBE between 0.65 and 0.8 was calculated from dose-effect curves. In the lower dose range a considerably faster recovery was observed after high-energy radiation than after conventional x rays. In further experiments, the seedlings were irradiated at various depths of a water-phantom. The RBE increased from 0.65 at the surface to values of about 1.35 in the region of the maximum dose. Similar results were obtained from experiments on E. coli in which the inactivation was observed after irradiation in the water-phantom. Here, the RBE reaches values of more than 2 at a depth of about 1 m of water. It is supposed that this RBE increase is due to the production of heavy particles in deeper layers of material. In the experiments on mice the animals were exposed to total-body irradiation, and the inhibition of the erythropoiesis was investigated by means of the radioiron utilization method. Simultaneously, the mortality rate was observed within 30 d after irradiation either with 3-GeV or 200-keV x rays. From these irradiations an RBE of 0.8 was also calculated. The same value was observed in genetical experiments on Drosophila and on E. coli. Here, however, the pattern of biochemical mutants was slightly different after both kinds of radiation. (auth)

33744 DOSIMETRIC PROBLEMS RAISED BY THE DETERMINATION OF RBE IN A LARGE ENERGY RANGE (ELECTRONS 15 TO 34 MeV AND PHOTONS 55 kV TO 20 MV). Wambersie, A. (Institut du Cancer, Louvain, Belg.); Dutreix, Andree. pp 261-72 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Experiments were performed in order to evaluate the RBE of high-energy electrons (15, 20, or 34 MeV) compared with high-energy photons (^{60}Co γ or 20 MV x rays). Several biological criteria were used: inactivation of microorganisms, the survival of mice irradiated in toto (2×600 rad), and chromosome aberrations in onion roots. No significant difference in the RBE and no differential effect were found. Kinetics of early recovery were compared for 34-MeV electrons and ^{60}Co γ using the split-dose technique. No difference was found. In these experiments the biological systems were irradiated in the plateau region of the electron depth-dose curve. Variation of RBE as a function of depth was investigated in an electron beam. No significant variation of RBE was found up to the 25 to 30% isodose level. Inactivation of microorganisms (20-MeV beam) and chromosome aberrations in onion roots (15-MeV beam) were used as biological tests. Chemical dosimetry ($FeSO_4$) was chosen as the reference for all these experiments. Variation of the RBE of photons as a function of energy was determined for an energy range between 20 MV and 55 keV. RBE of high-energy photons (several MV or tens of MV) was found to be about 0.85 to 0.90 compared with conventional x rays. For x rays the results tend to show a slow but regular increase in RBE when the energy decreases; this increase seems to continue for low-energy x rays. (auth)

33745 DUAL RADIATION INJURY AND ITS CONSEQUENCES. Rossi, H. H. (Columbia Univ., New York). Contract AT(30-1)-2740. pp 333-41 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

It is well known that for higher organisms the radiobiological effectiveness (RBE) is larger than 1.0 for radiations of high linear energy transfer (LET). It is also established that in general the RBE increases with decreasing absorbed dose. For a variety of effects this dependence can be expressed by a simple power function over wide ranges of the absorbed dose. The RBE is found at low levels of effect to conform with the expression $RBE = KD_x^{-n}$ where D_x is the absorbed dose of the reference radiation (x rays) and n and K are constants. n is frequently near 1.0 but with one possible exception never larger than one. As will be shown, the nature of this dependence indicates that the biological effects in cells are due to one or more elementary lesions that can be produced by one high LET particle but, in the range of doses under consideration, only by two low LET particles. Microdosimetric information can be utilized to derive some of the basic characteristics of these lesions. They appear to be due to energy depositions in very small (~1 nm) loci. Two such loci must be affected within a site that has much larger dimensions (>1 μm). These conclusions have a variety of implications. In radiological physics the need for certain microdosimetric measurements is indicated. In radiobiology some aspects of dose-effect relation and of recovery can be accounted for and more definitive questions can be posed regarding the action of modifiers of radiation sensitivity (oxygen, hydration, etc.). Finally, there are also tentative inferences that can be drawn relative to dose-effect relations near levels that are considered permissible in radiation protection. (auth)

33746 METABOLIC CHANGES IN MICE AFTER MODIFICATION OF RADIOSENSITIVITY. Streffer, C. (Univ., Freiburg i. B.). pp 525-37 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Characteristic changes of tryptophan and cysteine metabolism have been observed after whole-body irradiation of mammals. It was therefore of interest to study whether these metabolical systems were altered when the radiosensitivity of the mice was modified. The following modifying factors were investigated in this connection: environmental factors (hypoxia); physiological factors (age and sex); and chemical factors (1,1,2-trianisyl-2-chloroethylene, TACE). When mice were kept 10 days under hypoxic conditions (350 mm Hg air) the survival rate of the x-irradiated animals was changed in a characteristic mode during the days following termination of the hypoxia. It is well known that young mice are more radiosensitive than adults and male mice can tolerate less ionizing radiation than females. Consequently estrogens enhance the radioresistance of mammals when given some days prior to irradiation. The same effect is induced by the synthetic compound 1,1,2-trianisyl-2-chloroethylene. Under the above-mentioned modifying conditions the following biochemical parameters were investigated: several enzymatic activities in the liver including the decarboxylase for aromatic amino acids, the kynureninase, the kynurenine aminotransferase, and the cysteine oxygenase; the biosynthesis of NAD from tryptophan and nicotinic acid in the liver; and the excretion of anthranilic acid, kynurenic acid, xanthurenic acid, and taurine in the urine. In all cases the enzyme activities of the decarboxylase for aromatic amino acids and of the kynureninase were very low when the radiosensitivity on the mice was high. This led to an increase of the ratio kynurenine aminotransferase-/kynureninase-activity, and consequently the excretion of the kynurenic and xanthurenic acid was enhanced. The formation of NAD from tryptophan was decreased under these circumstances. Also there was found a reduced NAD level in the liver tissue when the radioresistance of the mice was diminished. On the other hand the cysteine oxygenase activity and the taurine excretion always rose when the radioresistance of the mice was high. It is suggested that the regulation of these biochemical processes can influence the radiosensitivity of the mice and the experimental evidence is discussed in relation to this. This assumption is supported by investigations on the NAD and on the tryptophan metabolism as well as on the DNA synthesis in regenerating liver. The experimental data show that an interrelationship between the mentioned three metabolic processes is very probable in this biological system. (auth)

33747 RADIATION PROTECTIVE STUDIES WITH COMBINATIONS OF CYSTEAMINE AND PENICILLAMINE. Grant, G. A.; Braceland, B. (Defence Research Establishment, Ottawa). pp 539-51 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Administration of penicillamine to cysteamine-treated mice did not affect the protective action of cysteamine against radiation. However, the administration of penicillamine to cysteamine-treated irradiated rat thymocytes abolished the protective action of cysteamine. This striking difference between the effects of penicillamine on cysteamine protection in vitro and in vivo may be due to the difference in local concentrations of the two compounds. In the in-vitro cellular system, more uniform local concentrations of penicillamine and cysteamine may exist, which would allow radical reactions to occur which may not occur in the whole animal. (auth)

33748 ANASTOMOTIC SARCOMA OF IRRADIATED PARABIONT RATS. Warren, S.; Hurst, E. E. Jr.; Brown, C. E.; Chute, R. N. (New England Deaconess Hospital, Boston. Univ. of Chicago). Contract AT(30-1)-3777. Cancer Res.; 32: No. 5, 983-7(May 1972).

In a series of 1003 pairs of parabiosed rats, in which the right partner of each pair received 1000 rads total-body irradiation, the incidence of soft-part sarcomas at the anastomotic site was 8.7%. The incidence in other parts of the irradiated partner was 5.8%, and in the nonirradiated partner it was 0.3%. A combination of whole-body irradiation plus local factors of continuing trauma and scar formation is thought to account for the higher incidence of sarcomas in the anastomotic region. Systemic factors such as the endocrines may also play a secondary role. (auth)

33749 TUMOR INCIDENCE IN RAT SKIN AFTER PROTON IRRADIATION IN A SIEVE PATTERN. Burns, F. J.; Albert, R. E.; Bennett, P.; Sinclair, I. P. (New York Univ., N. Y.). Radiat. Res.; 50: No. 1, 181-90(Apr 1972).

The dorsal skin of 183 male, albino rats was irradiated with 8.0 MeV protons at various doses in a uniform pattern and at two doses in sieve patterns with pore diameters of 5.0, 2.0, and 0.5 mm. The depth-dose curve of the proton beam was modified so that it was approximately linear with a maximum penetration of about 0.8 mm. Skin lesions were noted every 4 weeks for 80 weeks and at the end of the experiment were examined histologically. The results indicated that the sieve pattern did not significantly affect the tumor incidence per unit irradiated area or the incidence of damaged hair follicles at any pore size. This contrasts to the results of earlier experiments with electrons when a sieve pattern produced a significant protective effect at a pore diameter of 2.5 mm. Possible explanations for this discrepancy are discussed. (auth)

33750 PROTON AND ALPHA PARTICLE BOMBARDMENT OF MOUSE SKIN. Lippincott, Stuart W. (Virginia Commonwealth Univ., Richmond); Montour, James L.; Wilson, John D.; Rogers, Charles; Bender, Roger. Arch. Pathol.; 93: No. 5, 441-7(May 1972).

A total of 2,485 C3H male and female mice were bombarded with either protons or alpha particles at energies selected to penetrate 1.04 mm from the former and 0.62 or 1.02 mm in the latter. The bombardment was carried out so that essentially uniform ionization occurred throughout the total volume of tissue irradiated. The following range of doses was used: 5; 25; 50; 100; 250; 500; 1,000; 2,000; 5,000; and 10,000 rads. Of 855 mice that lived beyond one year, only 14 developed malignant neoplasms at the site of irradiation, with no skin neoplasms appearing anywhere else. The striking atypical hyperplasia that occurred as early as about 21 days never developed into neoplastic lesions. Permanent skin damage resulted primarily from fibrosis of limited thickness at 250 rads and with greater thicknesses at the higher doses. (auth)

33751 EFFECT OF INSULIN ON THE UPTAKE OF CREATINE-1-^{14}C BY SKELETAL MUSCLE IN NORMAL AND X-IRRADIATED RATS. Koszalka, Thomas R.; Andrew, Carole L. (Jefferson Medical Coll., Philadelphia). Proc. Soc. Exp. Biol. Med.; 139: No. 4, 1265-71(Apr 1972).

The uptake of labeled creatine by skeletal muscle was enhanced in rats treated with 2 units of NPH insulin on each of two successive days and then injected ip with creatine-1-^{14}C. While the uptake of labeled creatine by muscle was impaired in rats exposed to an x-ray dose of 500 rads, this impairment was relieved by treatment with insulin after x-irradiation. The level of radioactivity and the creatine concentration in whole blood was lower in insulin-treated rats injected ip with creatine-1-^{14}C than in untreated controls. In contrast, x-irradiated rats injected ip with labeled creatine exhibited higher levels of radioactivity and a higher creatine concentration in blood than did the sham-irradiated controls. When x-irradiated rats were treated with insulin, the amount of radioactivity and the creatine concentration in the blood 1 hr after the injection of labeled creatine was not significantly different from that in the sham-irradiated controls. These observations are consistent with the view that insulin enhances the transfer of creatine from the circulation into skeletal muscle in normal as well as in x-irradiated rats. (auth)

33752 NEUTRON-INDUCED MAMMARY NEOPLASMS IN THE RAT. Vogel, Howard H. Jr.; Zaldivar, Robert (Univ. of Tennessee, Memphis). Cancer Res.; 32: No. 5, 933-8(May 1972).

Female Sprague-Dawley/ANL rats were irradiated with single whole-body exposures of 5 rads of fission neutrons. More than

77% (21/27) of the exposed animals developed at least one mammary neoplasm during their lifetimes. The frequency of mammary neoplasms in this neutron-irradiated group was compared with that of similar rats exposed to either 100 or 300 R of 250-kVp x-rays, given also as single whole-body doses. The frequency of mammary tumors in the 5-rad neutron group was higher than that in the group of rats exposed to 100 R of x-rays over their entire lifetime. The relative biological effectiveness (X/n) for this system appears to lie between 20 and 60, an extremely high value for any mammal. Approximately 70% of the diagnosed tumors were benign, with fibroadenomas being the most common type of neoplasm. A comparison was made between partial- and whole-body exposures of female rats to a dose of 35 rads of fast neutrons. In the former case, one mammary gland was irradiated with neutrons of a mean energy of 540 ± 50 keV. In the latter case, rats were exposed to Argonne's CP-5 research reactor to a whole-body exposure of 35 rads of fission neutrons (mean energy, about 1 MeV). Seventy-five and 80% of these 2 groups of irradiated rats showed palpable mammary neoplasms during their lifetimes. No significant differences were observed in the histopathology of their neoplasms. Histopathological data were summarized for 126 mammary neoplasms in rats exposed to fission neutrons (single whole-body doses varying from 5 to 250 rads). Comparisons were made of mammary neoplasms induced by x- and γ-rays in Sprague–Dawley female rats in studies from 2 different laboratories. The results of the x- and γ-ray exposures were similar. (auth)

33753 EFFECTS OF AET ON CHROMOSOME REARRANGEMENTS INDUCED BY X-IRRADIATION IN SPERMATOGONIA. Leonard, A.; Deknudt, Gh. (CEN–SCK, Mol, Belgium). Radiat. Res.; 50: No. 1, 120-4(Apr 1972).

The influence of AET (2-aminoethylisothiuronium bromide hydrobromide) on cytologically detectable translocations at the diakinesis-first metaphase stage of meiosis was studied and compared with earlier data on dominant lethality. AET per se does not cause any additional translocations and is ineffective in modifying nature and rate of chromosome rearrangements induced by 500R given to spermatogonia of mice. The failure of AET to modify the rate of translocations induced by x-irradiation might be explained on the basis of some germinal selection but more likely could be related to a specific action of AET on a certain male germ cell stage. (auth)

33754 LYMPHOCYTOPOIETIC AND RADIOPROTECTIVE EFFECTS OF A HIGHLY PURIFIED CALF THYMUS PREPARATION. Sudo, Tadamitsu (Teikoku Hormone Mfg. Co., Ltd., Kawasaki, Japan); Funakoshi, Satoshi; Manita, Hideaki; (and others). Radiat. Res.; 50: No. 1, 136-57(Apr 1972).

Highly purified calf thymus preparations were obtained by sulfuric acid extraction procedure. These were further purified by ion-exchange chromatography on a CM-cellulose column. Among the preparations thus obtained, a 0.1 N HCl eluted fraction (CM-3) showed such distinct biological activities as promotion of lymphocytopoiesis, mainly of small lymphocytes in neonatally thymectomized mice and the protective modification of radiation injuries. As control samples, the equivalent spleen and liver preparations, 2-aminoethylisothiuronium (AET), and bovine serum albumin were used in these experiments. Although there was no definite organ or substance specificity in survival tests, thymus but not spleen and liver extracts were effective. On bone marrow nucleated cellularity, CM-3 showed marked protection in comparison with that injected with an equivalent dose of AET. The effect of this purified thymus preparation was also tested on small intestine disaccharidase activities of lethally irradiated mice. The enzymatic activities, based on the measurement of maltase and trehalase, were protected by the treatment, indicating that the test might be useful in evaluating the efficiency of radioprotective agents in animals irradiated with high dose level. It is suggested that the biological activities of thymic preparations shown in the present studies are associated, in some way, with thymic histone in those sulfuric acid extracts. (auth)

33755 CELL KINETICS OF EPIDERMAL REPOPULATION AND PERSISTENT HYPERPLASIA IN LOCALLY β-IRRADIATED GUINEA PIG SKIN. Yamaguchi, Takeo; Tabachnick, Joseph (Albert Einstein Medical Center, Philadelphia). Radiat. Res.; 50: No. 1, 158-80(Apr 1972).

The alterations in cell kinetics which result in epidermal repopulation and persistent hyperplasia were studied in guinea pig skin after 3000 rep β-irradiation from a ^{90}Sr–^{90}Y sealed source. The first sign of an increase in the thymidine (^{3}H-TdR) labeling index (LI) was observed at the margins of the irradiated site about 10 days after irradiation at a time when severe depopulation was progressing within the 25 mm^2 irradiated area. Marked hyperplasia became evident at the radiation margin 12–14 days post-irradiation. Shortly thereafter cells at the margin spread over the depopulated area (epithelization) covering it within 7 days. In unirradiated epidermis, the mean generation time (T_c) of basal cells was 91-92 hr (T_{g1} = 76-77, T_s = 9.3-9.6, T_{g2} = 5.0-5.6, and T_m = 0.4-0.6 hr). After irradiation, ^{3}H-TdR labeling revealed two types of hyperplasia; the first, that of the migrating epithelium, consisting of germinative cells with a shortened mean T_c of about 16 hr and high LI. The shortened T_c was largely the result of a drastic decrease in T_{g1} to 3-4 hr. T_{g2} also decreased to 2.3-2.6 hr. T_s and T_m remained unchanged. Between days 21 and 30, the first type of hyperplasia was transformed into the second, a long-lived thickened (acanthotic) epidermis, whose germinative cells had reverted to a cell cycle time and LI similar to unirradiated epidermis. It persisted for 150 days and longer. The differentiation rate of the basal-spinous cell population was 7-8 days in the control, 3-4 days during epithelization, and 14-15 days in the acanthotic epidermis 50 days or later postirradiation. The main factors contributing to the maintenance of the acanthotic epidermis were the slower differentiation rate and increased number of DNA synthesizing basal-spinous cells per unit length. (auth)

33756 MORTALITY RESPONSE OF MICE AFTER WHOLE-BODY EXPOSURE TO 1.7 TO 5 MeV NEUTRONS AND X RAYS. Otto, Friedrich H.; Pfeiffer, Ulrich (Fraunhofer-Gesellschaft, Stuttgart). Radiat. Res.; 50: No. 1, 125-35(Apr 1972).

The mortality response of male NMRI mice to whole-body irradiation with fast neutrons of the energy range from 1.7 to 5 MeV was studied and compared with the effects of 250 kV x-rays. Fast neutrons were confirmed to be very effective for the induction of early death. With increasing doses of neutrons survival time decreased more rapidly than with x-irradiation so that, in progressing from midlethal to lethal exposures, mean survival time became markedly lower than after equivalent doses of x-rays. The variance in death time was significantly greater in neutron than in x-ray experiments. This reflects the efficiency of additional killing mechanisms attributed to acute gastrointestinal damage. Mean lethal dose was used to determine the relative biological effectiveness of neutrons. The $LD_{50(30)}$ was 293 rads for neutrons and 479 rads for x-rays. From these data, taking account of the additional gamma-ray component, the RBE of neutrons was calculated to be 1.5. (auth)

33757 LIGHT AND ELECTRON MICROSCOPY OF LESIONS INDUCED BY IONIZING PARTICLES IN THE CENTRAL NERVOUS SYSTEM. Estable-Puig, J. F.; de Estable, Rosita F.; Haymaker, W. (Univ. Laval, Quebec). Acta Neurol. Latinoamer.; 15: 53-71(1969). (In Spanish).

The present work represents a light and electron microscopy study of cortical lesions produced by irradiation to the heads of rats with different doses of alpha particles from two different accelerators. In the animals irradiated with 6.000 rad, a process of demyelination and remyelination took place in the cerebral and cerebellar cortex in the region of maximal ionization. The animals irradiated with higher doses showed a process of acute superficial radionecrosis characterized by: destructive alterations throughout the irradiated tissue, early demyelination, primary neurogliopil necrosis, presence of abundant gitter cells, accumulation of glycogen and diverse nucleolar alterations in glial cells. (auth)

33758 MECHANISMS OF CHANGES OF SEROTONIN CONTENT IN THE TISSUES OF IRRADIATED ANIMALS. Goncharenko, E. N.; Subbotina, S. M.; Alieva, L. I. (Moscow State Univ.). Biol. Nauki; No. 12, 41-4(1970). (In Russian).

The influence of various radiation doses on the activity of 5-hydroxytryptophanedecarboxylase and monoaminoxidase in animal tissue was studied. White rats were given a 1,000 R dose of x radiation and then decapitated 30 min, 24, and 72 hr later for the purpose of measuring the enzyme activity in tissues of the intestines, stomach, liver, and brain. The activity of 5-hydroxytryptophanedecarboxylase (measured in terms of μg of serotonin) peaked at 30 min after irradiation in the intestines and liver, but at 24 hr in the brain. The activity of mitochondrial monoaminoxidase was slightly higher in the controls than in post-irradiation tissues. (K.S.W.)

33759 ESTIMATION OF RADIATION-INDUCED MITOTIC DELAY IN MAMMALIAN TISSUES AND CELL CULTURES. Strzhizhovskii, A. D. Tsitologiya; 14: No. 2, 158-64(Feb 1972). (In Russian).

A method for calculation of the first post-irradiation cell cycle duration on the basis of post-irradiation mitotic index dynamics is described. Literature experimental data analysis with the use of the described calculation method enabled the author to estimate the mitotic delay induced by x- and γ-rays, high energy protons, and by fission neutrons in bone marrow, cornea, and intestine of rodents and in some mammalian tissue cultures. It is shown that the mitotic delay duration increases linearly with the dose of x- and γ-rays and ranges between 0.9 and 6.6 min per rad for the cell types investigated. Relative biological efficiency coefficients, estimated according to the value of mitotic delay, range between 0.8 and 1.0 for protons, and 1.4 and 2.6 for neutrons. (auth)

33760 STUDIES OF THE MECHANISMS INVOLVED IN RADIATION-CONDITIONED SACCHARIN AVOIDANCE AND RADIATION AND ACTINOMYCIN-D-INDUCED BIZARRE EATING IN RATS. Gould, Michael N.; Yatvin, Milton B. (Univ. of Wisconsin, Madison). Int. J. Radiat. Biol.; 21: No. 3, 215-22(Mar 1972).

The mechanisms involved in bizarre eating in x irradiated and in actinomycin-D-treated rats, and conditioned saccharin avoidance in irradiated rats, were investigated. Epinephrine, carbachol, gastrin, secretin and atropine sulphate were employed in an attempt either to mimic or prevent the above behavior patterns. With the exception of atropine sulphate none of the agents, which were known to alter the functional state of the stomach, either inhibited or induced the behavioral actions. Atropine sulphate inhibited the bizarre eating induced by both irradiation (850 R) and actinomycin-D. It also inhibited the radiation-induced conditioned aversion to saccharin. The degree of inhibition of the conditioned saccharin avoidance was shown to be dependent on the dose of radiation. (UK)

33761 ULTRASTRUCTURE OF LYMPH NODE PLASMOCYTES APPEARING AFTER IRRADIATION. Simar, L. J. (Univ., Liege). Bull. Cancer; 58: No. 3, 393-410(Jul-Sep 1971). (In French).

A total body irradiation of 450R produces a plasma cell surge in mice with a simultaneous inhibition of antibody production. Optical microscope studies indicate that these post-irradiation plasma cells are identical to those observed during immunization. Ultrastructure studies indicate that, in both cases, they develop in the same region of the node and according to the same sequence. Furthermore, they appear to have the same origin. Electron microscope examination reveals that plasma cells, which have been subjected only to irradiation, have the same principal characteristics as plasma cells developing in nodes after the injection of antigen; they may, however, be distinguished by the fact that they contain myelin bodies at various sites in the cytoplasm and nucleus, and that the nuclear bodies are either too few in number, or abnormal. The relation between the scarcity of plasma cell nuclear bodies and the inhibition of antibody production in mice is discussed. (France)

33762 RADIATION RESISTANCE AND TEMPERATURE ADAPTATION OF MICE. Locker, A.; Bauer, D. (Reaktorzentrum, Seibersdorf, Austria). Stud. Biophys.; 28: No. 2, 105-9(1971). (In German).

Mice which were adapted to ambient temperatures of 12.5°C and 32.5°C, respectively, show an increased radioresistance against γ-rays, as compared with unadapted control animals. Effects of temperature on survival of irradiated mice are shown by means of graphs. (H.L.W.)

33763 QUANTITATIVE ESTIMATION OF PERSISTENCE OF CHROMOSOME ABERRATIONS IN MAMMALIAN TISSUE CELLS IN VIVO. Strzhizhovskii, A. D. (Inst. of Medical and Biological Problems, Moscow). Genetika; 8: No. 2, 93-100(Feb 1972). (In Russian).

The mean time of persistence of chromosome aberrations induced by roentgen and γ irradiation, fission neutrons and high energy protons in bone marrow, thymus, corneal and intestinal epithelium cells was estimated. The value of the criterion practically did not depend on the dose, but it was different in different tissues. In similar tissues mean persistence time of chromosome aberrations increased with the increase of proliferative activity. In tissues with short persistence it depended slightly on the type of irradiation. Possibilities of the criterion used for estimation of a mean division number of the aberrant cell before its reproductive death are discussed. (auth)

33764 RADIATION-INDUCED CHROMOSOME ABERRATIONS IN CHINESE HAMSTER LEUKOCYTES. A COMPARISON OF IN VIVO AND IN VITRO EXPOSURES. Preston, R. J.; Brewin, J. G.; Jones, K. P. (Oak Ridge National Lab., Tenn.). Int. J. Radiat. Biol.; 21: No. 4, 397-400(Apr 1972).

X-ray dose-response curves are presented for dicentric and centric ring aberrations in Chinese hamster leukocytes, following in vivo and in vitro irradiation, using a modified diffusion chamber culture technique. Three hundred metaphases were analyzed at each of in vivo doses of 50 and 200 R. At least 100 metaphases were also analyzed from both peripheral blood and lymph node cultures at in vitro doses of 0, 50, 100, 200, 300, and 400 R. There was no difference between the yields of dicentrics plus centric rings, or deletions induced in peripheral leukocytes irradiated in vitro or in vivo, or in leukocytes from lymph nodes irradiated in vitro. The yield of dicentric plus centric ring aberrations for the Chinese hamster was one-half that for humans at any dose, but the yields of deletions were not significantly different in the two species. (UK)

33765 CELL RECOVERY IN FOETAL BRAIN AFTER IONIZING RADIATION. Brizzee, K. R.; Brannon, R. B. (Tulane Univ., Covington, La.). Int. J. Radiat. Biol.; 21: No. 4, 375-88 (Apr 1972).

Timed-pregnancy rats were exposed on gestation day 13 to single doses of gamma (^{60}Co) irradiation of from 25 to 200 R in increments of 25 R, and to split doses of 100 R plus a second dose of from 25 to 150 R in increments of 25 R, with a 9-hr interval between exposures. Additional animals were exposed to the same split-dose regimens, but with induction of hypothermia—hypercapnia after the initial dose of 100 R (deep colonic temperature about 20°C) and recovery to normal temperature levels in about $5\frac{1}{2}$ hr. Others received a single dose of 100 or 150 R followed by induction of hypothermia—hypercapnia, but without exposure to a second radiation dose. The incidence and severity of tissue alterations on gestation day 19 generally varied directly as dose-level. Such alterations were clearly greater in single-dose than in split-dose groups at comparable total dose-levels. In split-dose groups with induction of hypothermia—hypercapnia between exposures, tissue damage was greater than in the split-dose group but somewhat less than in the single-dose group. Dose—response curves based on semi-log plots of mean cross-sectional area of cortical plate revealed a threshold (shoulder) zone on both the single-dose and split-dose curve. The latter suggests the possibility of cell recovery in the 9-hr interval between exposures. Values for cross-sectional area of cortical plate in animals subjected to hypothermia—hypercapnia in the 9-hr interval between exposures were lower than those of the split-dose series. It is suggested that repair processes in the interval between exposures may have been inhibited by the hypothermia—hypercapnia. Additional factors that may account for the observed results are discussed. (auth)

33766 EVOLUTION OF THE BONE-MARROW LYMPHOID CELL POPULATION IN SUBLETHALLY IRRADIATED MICE TREATED WITH CORTISONE. Schmitz, A; Haot, J. (Univ., Liege). Compt. Rend. Soc. Biol.; 165: No. 5, 1186-8(1971). (In French).

A cortisone treatment of mice, irradiated with a sublethal 400 R dose, stops the accumulation of the lymphoid type mononuclear cells normally observed between the 10th and 12th day after irradiation. Furthermore, no lymphoid peak is observed with these animals, even several days after ceasing the treatment. The cortisone action mechanism is thus not explained by a blocking of the lymphoid cell multiplication, but by a toxic action occurring in the cells. (France)

33767 DISTRIBUTION AND METABOLISM OF THE RADIATION PROTECTIVE AGENT AMINOPENTYLAMINOETHYLPHOSPHOROTHIOATE IN MICE. Kollmann, George; Martin, David; Shapiro, Bernard (Albert Einstein Medical Center, Philadelphia). Radiat. Res.; 48: No. 3, 542-50(Dec 1971).

The distribution and metabolism of the radiation protective agent aminopentylaminoethylphosphorothioate (WR-2823) were studied in C57BL/6J mouse tissue homogenates in vitro and in C57BL/6J mice in vivo. Greater excretion of the administered agent and less metabolism to the dephosphorylated form were observed with WR-2823 as compared with aminoethylphosphorothioate (WR-638) previously studied at equiprotective doses. In comparing the three protective agents, WR-2823, WR-638, and 2-mercaptoethylguanidine (MEG), the chemical form that best correlates with protection is the protein-bound form. All three agents form mixed disulfides with protein sulfhydryl groups and this appears to be the protective form. Dephosphorylation must occur with the phosphorothioates before they can form mixed disulfides with protein. The high toxicity of WR-2823 is probably due to its slower dephosphorylation. Differential metabolism was observed among the tissues and could be the basis for differential protection, a phenomenon with possible practical applications. (auth)

33768 EPIDERMAL-CELL POPULATION CHANGES PRODUCED BY EXPOSURE TO 2300 R. Archambeau, John O.; Gerber, Anne; Ayoub, Rafik; Brenneis, Harry J. (Nassau County Medical Center, East Meadow, N. Y.). Radiology; 103: No. 1, 191-6(Apr 1972).

The histological changes produced by x irradiation of a 10 cm (diameter) field on the shoulder of immature swine could be divided into degenerative and regenerative phases. The degenerative phase was characterized by progressive cell loss, increased nuclear volume, and a lower mitotic index. The cell loss was complete or maximal by twenty-one days. The regenerative phase was characterized by discrete islands of proliferating cells, first seen at twenty-one days. These islands increased in diameter; by twenty-eight days they had fused into a re-epithelialized surface which then became hyperplastic. The apparent doubling time of the regenerating phase was 3.3 days. (auth)

33769 DIRECT IN VITRO ASSAY FOR STUDYING RADIOSENSITIZATION IN MAMMALIAN CELLS. Byfield, J. E.; Lee, Y. C.; Bennett, L. R. (Univ. of California, Los Angeles. Harbor General Hospital, Torrance, Calif.). Radiology; 103: No. 1, 201-3(Apr 1972).

Radiosensitization was quantitatively evaluated in mouse leukemia cells exposed to γ radiation in vitro. Results showed that a specific radioassay for radiosensitization using Actinomycin D is feasible. The procedure is adaptable to the clinical limitations of biopsy specimens. (auth)

33770 EFFECT OF A NORMAL HAEMOPOIETIC GRAFT ON LYMPHOID BONE-MARROW REGENERATION IN IRRADIATED MICE. Ikeh, V.; Delrez, M.; Haot, J. (Univ., Liege). Compt. Rend. Soc. Biol.; 165: No. 5, 1189-90(1971). (In French).

The lymphoid proliferation observed 12 days after 400 to 700R irradiations can be inhibited by a graft of normal bone marrow containing between 5 and 30 million cells. The effectiveness of the graft increases with the dose and the number of grafted cells. The results suggest the existence of a competitive process between the lymphoid population of the irradiated bone marrow and the normal medullary cells of the graft. (France)

33771 INDUCTION OF MURINE LEUKAEMIA: INTERACTION OF VIRUSES, TARGET CELLS, HOST FACTORS, AND EXOGENOUS AGENTS. Kaplan, Henry S. (Stanford Univ., Calif.). pp 13-22 of Nature of Leukaemia. /Vincent, P. C. (ed.). Sydney; Australian Cancer Society (1972). (CONF-720321-1).

From International cancer conference; Sydney, Australia (13 Mar 1972).

The viral etiology of mouse leukemias is reviewed. The radiation induced leukemia (RadLV) virus known mode of transmission is described (this virus has also been extracted from chemically induced lymphomas). The viral component of the oncogenic system, the interactions of the thymus, bone marrow, constitutional and environmental factors affecting the host, and external physical or chemical inducing agents are reviewed. Four different effects induced by x irradiation on C57BL mice are identified as activation and release of RadLV, thymic injury and regeneration, injury to the bone marrow, and immunosuppression. Multiple injections of interferon administered to groups of C57BL mice treated respectively with leukemogenic x-ray doses or with RadLV, demonstrated a significant decrease in lymphoma incidence compared with controls. This supports the view that the virus is the etiologic agent responsible for lymphoma induction and that x irradiation acts as a trigger to alter the host-virus relationship. (Australia)

33772 STUDIES ON THE EFFECTS OF ATP ON GASTRIC SECRETION IN NORMAL IRRADIATED ANIMALS. Groza, P.; Gheorghe, N. Rev. Roum. Physiol.; 9: No. 1, 3-8(1972). (In French).

The complex gastric secretion of dogs was analyzed following reflex and humoral stimulation; it was found that ATP has an inhibitory action through a peripheral mechanism. In the rat, ATP inhibited gastric secretion. Its inhibitory effect is probably due to a negative feed-back action on the processes of oxidoreduction which are fundamental to the synthesis of hydrochloric acid and gastrin. The gastric secretion was reduced by a 500 R dose of radiation; this effect was attenuated by ATP administered 30 min after irradiation. If administered before irradiation, the ATP did not modify the secretion significantly. (tr-auth)

33773 GLYCINE METABOLISM AND ITS ROLE IN BIOCHEMICAL RADIOPROTECTION. Capalna, S. (Dept. of Clinical Biochemistry, Bucharest). Rev. Roum. Physiol.; 9: No. 1, 17-34(1972).

Investigations with isotopically labelled glycine have revealed that this amino acid can be transformed under metabolism to formate, acetate, ethanolamine, glutathione, creatine, serine, aspartic acid fatty acids, purines, pyrimidines, ribose, protoporphyrin, hemoglobin, cytochromes, catalase and peroxidase. As a result, glycine may play a role in carbohydrate, protein, lipid, nucleic acid, hemoglobin and cytochromes metabolism and for this reason a greater diversity of metabolic pathways for a single amino acid could play an important role also in biochemical radioprotection. (auth)

33774 EFFECT OF 1200 R OF X RADIATION ON THE GROWTH OF BONE AND DENTINE IN THE MANDIBLE. Adkins, K. F. (Univ. of Queensland, Brisbane). Ala. J. Med. Sci.; 5: No. 4, 409-14(Jul 1968).

The effects produced by 1200 R of x-radiation on growing bone and dentine in the mandible were studied in albino rats. Foreshortening of the irradiated mandibles was apparent within seven days. There was some indication that the most severe effects resulted when the radiation was administered in a single dose but statistical analysis failed to show any significant differences between the three dose/time patterns used. There were no statistically significant dimensional differences between the femurs which were protected during irradiation. Reduction in the amount of dentine apposition was apparent 28 days following 2 × 600 R of x-radiation. No other quantitative aberrations were noted in dentine. (auth)

33775 RETARDATION OF CEREBELLAR AND MOTOR DEVELOPMENT IN RATS BY FOCAL X-IRRADIATION BEGINNING AT FOUR DAYS. Anderson, William J.; Altman, Joseph (Purdue Univ., Lafayette, Ind.). Physiol. Behav.; 8: No. 1, 57-67(Jan 1972).

The cerebellum of rats was irradiated daily from four to thirteen days of age. This resulted in subtotal elimination of the postnatally-formed interneurons, with minimal distortion of the lobular and laminar organization of the cerebellar cortex. The population of Purkinje and Golgi cells was slightly reduced, and Purkinje cells were found in various pathological states. The motor development of these animals was observed between 14 to 30 days of age by recording various spontaneous activities, and were tested on a vertical rope on which they had to descend to the ground, and a vertical rod on which they had to climb up to a landing platform. The irradiated animals tended to be more active than the controls in locomotion, but they displayed severe coordination difficulties which gradually improved in some tests as they became older. They fell more while in motion or at rest and displayed difficulty in transferring their body from a rod on which they had climbed up, to a landing platform, because of the inability of the hindlimbs to support the body. (auth) (UK)

33776 RESPONSIVENESS OF THE X-IRRADIATED ADRENAL CORTEX TO ADRENOCORTICOTROPHIN IN DOGS. Yamashita, K.; Shimizu, T. (Nagasaki Univ., Japan). J. Endocrinol.; 52: No. 1, 199-200(Jan 1972).

Observations were made on adult dogs for up to 14 days after x irradiation (2000R) of one adrenal gland. Control non-irradiated dogs receiving intravenously 5 mu. adrenocorticotrophin (ACTH), showed an increase in the secretion of adrenal 17-hydroxycorticosteroid (17-OHCS) 15 min after inspection, but the effect did not last more than 30 min. Two days after irradiation, 17-OHCS secretion in irradiated dogs which had received ACTH, increased markedly at 15 and 30 min. and at 60 min. remained appreciably increased above pre-injection levels. At 7 and 14 days after irradiation, there were increases in secretion of 17-OHCS after injection of ACTH. In most cases the increased rates were sustained for up to 60 min., but a return to pre-injection levels tended to occur by 90 min. (UK)

Invertebrates

Refer also to abstracts 33640 and 33665.

33777 (AEC-tr-7303, pp 105-11) INFLUENCE OF NaF ON THE FREQUENCY OF RECESSIVE LETHAL SEX LINKED MUTATIONS IN DROSOPHILA MELANOGASTER, INDUCED BY IRRADIATION UNDER AEROBIC AND ANAEROBIC CONDITIONS. Ivashchenko, N. I.; Grozdova, T. Ya.; Kholikova, T. A. (Inst. of General Genetics, Moscow). Translated from Radiobiologiya; 11: No. 3, 396-400(May-Jun 1971).

It was discovered that an inhibitor of glycolytic phosphorylation somehow modifies the genetic response of the germ cells of Drosophila to the action of ionizing radiation; under aerobic conditions of irradiation the influence of NaF is manifested only on mature germ cells, while under anaerobic conditions it is also manifested on maturing germ cells. (tr-auth)

33778 IMMUNE RESPONSE OF CATTLE INOCULATED WITH IRRADIATED BABESIA BIGEMINA. Bishop, John Philip. College Station, Tex.; Texas A and M Univ. (1971). 151p. University Microfilms Order No. 72-13,200.

Thesis.

Experiments were performed to separate Babesia bigemina from Babesia argentina, Babesia major, and Anaplasma marginale. The method of separation was rapid passage through 5 splenectomized calves. Five blood passages were carried out in 6½ days. Babesia argentina, B. major, and A. marginale were eliminated as contaminants after 4 passages. A frozen stabilate of the isolated B. bigemina was established. A method for the preparation and examination of combination thin and thick blood films for the detection of Babesia parasitemia was developed. The technique for the staining of the combination thin and thick films involved the use of a phosphate buffered Giemsa stain solution containing alkyl phenoxy polyethoxy ethanol. Babesial complement fixation (CF) antigens were also prepared and titrated for use in a CF microtiter procedure. Babesia bigemina parasitized blood exposed to varied doses of gamma radiation up to 60 kRad was inoculated into calves. Calves infected with 1 × 10^{10} B. bigemina parasitized erythrocytes exposed to doses up to and including 30 kRad developed progressive parasitemias. Some calves receiving 1 × 10^{10} parasitized erythrocytes irradiated at levels of 36 and 42 kRad did not develop progressive infections. Progressive infections were prevented by exposure to irradiation at 48 kRad or higher. Subinoculations into susceptible splenectomized calves from parasites thus treated failed to produce active infections. In addition to a lower infection rate brought about by irradiated parasites, calves that did become infected had prolonged prepatent periods and lower maximum parasitemias. Control calves, however, that had been inoculated with 1 × 10^7 nonirradiated parasitized erythrocytes also had prolonged prepatent periods and lower maximum parasitemias. Therefore, the prolonged prepatent periods and lower maximum parasitemias in calves that had received 1 × 10^{10} irradiated B. bigemina could have been partly due to a reduction in the number of viable parasites injected. The finding that calves inoculated with 1 × 10^7 nonirradiated parasitized erythrocytes had prolonged prepatent periods and lower maximum parasitemias indicates that such a standardized inoculum might be of use as a vaccine to produce an attenuated infection. (Diss. Abst.)

33779 EFFECT OF IRRADIATION ON INTRA-ERYTHROCYTIC STAGES OF BABESIA MAJOR. Brocklesby, D. W.; Purnell, R. E.; Sellwood, Sylvia A. (Agricultural Research Council, Newbury, Eng.). Brit. Vet. J.; 128: No. 1, iii-iv (Jan 1972).

Bovine erythrocytes infected with Babesia major were subjected to irradiation from a ^{60}Co source before being injected into splenectomized calves. A dose of 10 kilorads (krad) had no apparent effect on the parasites; 30 krad had a marked effect and 50 krad killed them. The results of challenge were difficult to interpret owing to the appearance of Eperythrozoon tuomii which is reported for the first time in Britain. (auth) (UK)

33780 IMMUNIZATION OF MONKEYS AGAINST PLASMODIUM CYNOMOLGI BY X IRRADIATED SPOROZOITES. Collins, W. E.; Contacos, P. G. (Nationat Inst. Allergy and Infectious Diseases, Atlanta). Nature (London) New Biol.; 236: No. 67, 176-7(12 Apr 1972).

Laboratory bred Anopheles mosquitoes infected with the B strain of Plasmodium cynomolgi were x irradiated with a dose of 13 krad. Within 1 hr of irradiation, a saline preparation of the mosquito salivary glands was injected intravenously into 2 juvenile Macaca mulatta monkeys. Repeat injections were carried out over a period of 124 days and each animal received an estimated 70,000 to 125,000 sporozoites. The two monkeys and a control were then bitten by 5 or 6 mosquitoes heavily infected with a homologous strain of the parasite. Results indicated that the prepatent periods were delayed from 2 to 5 days, but that the immunization failed to protect from ultimate malarial infection. (UK)

33781 BIOLOGICAL EFFECTS OF VERY HIGH ENERGY NUCLEI OF HIGH Z. Bond, V. P. (Brookhaven National Lab., Upton, N. Y.). pp 369-81 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Stripped atomic nuclei of very high energy (1000 MeV/amu or greater) are encountered in outer space. These energetic nuclei can penetrate, in essentially straight-line trajectories, tens of centimetres into tissue. Throughout the trajectory, the energy is deposited at very high densities in the track core of some 10 to 50 Å in diameter, and in delta-rays that may penetrate laterally as much as 50 μm or more in a sensitive film. At least half the total energy is absorbed in the core; absorption falls off roughly as $1/r^2$ with lateral distance. The dE/dx, or LET_∞, increases as the particle slows down (the "thin down" region of the track); also the range of the delta-rays diminishes appreciably near the end of the range. The biological effects of these heavy particles are only poorly characterized, since particles with enough penetrating power have not been produced in the laboratory, and since fluxes in outer space are too low for adequate study. Some data are available on medium-energy, medium-Z particles produced with the Hilac, and from studies in balloon flights. These data suggest that above some threshold value of LET, modes of cell inactivation or killing not previously known may come into play. The cross-section for cell inactivation in the track core may be essentially that of the entire cell, and thus a column of cells along some segment of the particle track may be inactivated with the probability of 1.0. Because the distribution of deposited energy from galactic particles is non-uniform at both micro and macro levels, the averaging of energy density over relatively large volumes of tissue (calculation of average doses) has not the same meaning or usefulness as with ordinary radiations. The absorbed dose, the quality factor and the rem have little or no usefulness in characterizing the radiation field, the overall probability of effect, or the degree of hazard relative to that from ordinary laboratory radiations. (auth)

33782 SOME PARAMETERS OF MITOTIC RECOMBINATION IN DROSOPHILA MELANOGASTER. Garcia-Bellido, A. (Instituto de Genetica y Antropologia, Madrid). Mol. Gen. Genet.; 115: No. 1, 54-72(1972).

Somatic mosaicism in the tergites has been studied in both irradiated and control individuals. Several cell marker mutants, corresponding to eleven different loci scattered along the five major chromosome arms, have been characterized for their penetrance in marking spots. Several of these mutants belonging to the same chromosome arms in cis and trans configuration yield comparable values of mosaicism, thus indicating their origin by mitotic recombination. Moreover, spots corresponding to double crossing-over events have been detected. Recombination frequencies for mutants located in different chromosome arms have been studied in multiple heterozygous individuals. Their recombination frequencies are characteristic of the distances between their loci and their corresponding centromeres. From the data on mitotic recombination for different loci of the same chromosome arm and of different chromosomes a mitotic recombination map was constructed. The map deriving from spontaneous recombination data differs in several respects from the data gained from irradiation experiments. The location of the different markers in irradiation experiments corresponds well with their cytogenetic location in the mitotic chromosomes. Structural, physiological and developmental restrictions of mitotic recombination are discussed. (auth)

33783 RADIATION INDUCED CROSSING-OVER IN DROSOPHILA MALES (A CYTOLOGICAL STUDY). Mglinets, V. A. (Inst. of Medical Radiology, Obninsk, USSR). Genetika; 8: No. 2, 82-92 (Feb 1972). (In Russian).

In the 5th to 15th broods obtained from gamma-irradiated (1000 R) Drosophila melanogaster males 201 crossovers were found. 158 recombinant chromosomes were studied cytologically; 34 of them were associated with chromosomal mutations (24 duplications and deficiencies, 9 inversions and translocations and one insertion). Among 359 irradiated non-recombinant chromosomes 11 chromosome mutations were found (inversions and translocations). Chromosome rearrangements involving recombinant chromosomes were found mainly in broods corresponding to germ cells irradiated during meiosis, while the rearrangements involving non-recombinant chromosomes were found mostly in postmeiotic broods. A comparison of the points of induced crossing-over with the localization of chromosome breaks in respective chromosome rearrangements indicates that the induction origin of the crossover is due to the induction of chromosome rearrangements. It is suggested that the induced recombination may arise either as usual crossing-over, or by means of translocation-like mechanism, depending on the spatial position of homologous chromosomes. (auth)

33784 DEPENDENCE OF THE FREQUENCY OF RADIATION INDUCED ANEUPLOIDY ON CHROMOSOME LENGTH IN DROSOPHILA MELANOGASTER. II. CHROMOSOMES X AND CHROMOSOMES DUPLICATION X-4. Glotov, N. V.; Zakiev, R. K. (Moscow State Univ. Kazan State Univ.). Genetika; 8: No. 2, 76-81(Feb 1972). (In Russian).

Frequencies of radiation induced (at doses of 1, 2, 3, 4 and 5 kR of ^{60}Co gamma-rays) increases of non-disjunction and the loss of X's and chromosome duplications X-4 in females y^2/y^2; T (3; 4) 86D, red/T (3, 4) 86D, red; Dp (1; f) 1144, y^+ac^+/ci^D mated with XY, B/Y males are compared. It is shown that the increases of chromosome non-disjunctions are greater for short chromosomes and the increases of chromosome loss are greater for long chromosomes. This is in accordance with the results of the previous work. The comparison of the frequencies of induced aneuploidy, registered in the progeny of two to three day old irradiated females with subsequent three-day period of egg laying, with the frequencies registered in 10 hour old irradiated females failed to show a significant difference between them. This means that the simplified method is identical to the registration of the irradiation results of stage 7 oocytes provided by using high irradiation doses. (auth)

33785 STUDY OF FRACTIONATED EFFECT OF ETHYLENEIMINE ON THE MUTATION RATE IN DROSOPHILA MELANOGASTER. Shvartsman, P. Ya.; Bondarenko, L. V.; Vanyan, L. A.; Kuznetsov, V. M. (Pedagogical Inst., Leningrad). Genetika; 8: No. 1, 85-94(Jan 1972). (In Russian).

The frequency of lethal recessive sex-linked mutations induced by the continuous and fractionated treatment of 3 day-old Drosophila males with ethylenimine vapor was investigated. It was shown that frequency of mutations after fractionated treatment as compared with continued treatment increased at high concentrations of ethylenimine solution in desiccator. The decrease in ethylenimine concentration leads to the decrease in fractionation index (K) calculated as ratio of mutation frequency after fractionated treatment to that after continued treatment. Meanwhile variations in ethylenimine concentrations of 0.25% to 2.0% did not cause the change in the frequency of mutations, the last increasing with the prolongation of the time of mutagen exposure. When the time between single fractions of ethylenimine was prolonged, the frequency of mutation increased also at all the concentrations of mutagen. Maximum in the frequency of mutations was noted at a 16-h interval between fractions. Combined effect of ethylenimine and x irradiation led to the additive effect that did not depend on the time between fractions. A possible mechanism of split-dose effect of ethylenimine is discussed. (auth)

Radionuclide Effects (Internal Source)

Refer also to abstracts 33744 and 33822.

Man

Refer also to abstract 33688.

33786 IN VITRO MIGRATION MEASUREMENTS OF ALVEOLAR HISTIOCYTES: COMPARATIVE EFFECT OF ANTISERUMS AND PLUTONIUM OXIDE POISONING. Nolibe, Daniel (Centre d'Etudes de Bruyeres-le-Chatel, Montrouge, France. Univ., Paris). Compt. Rend., Ser. D; 274: No. 1, 77-80(3 Jan 1972). (In French).

The inhaling of a toxic substance in the form of particles e.g., plutonium oxide adversely affects the pulmonary cleaning system. This is partly due to the active displacement of alveolar histiocytes. It is thus interesting to quantitatively evaluate the migratory power of these cells. A quantitative test was developed for measuring the migratory activity of healthy histiocytes, those treated with an antiserum, or those having phagocytized a toxic product. The measurements were tested using the migration in capillary tube method. (France)

33787 LOCAL ENERGY DEPOSITION IN THYROID CELLS DUE TO THE INCORPORATION OF ^{125}I. Feige, Y. (Soreq Nuclear Research Centre, Yavne, Israel); Gavron, A.; Lubin, E.; (and others). pp 383-404 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

By substituting ^{125}I for equal activities of ^{131}I, an apparent reduction is obtained in the calculated average radiation dose delivered to thyroid tissue. This has led to the increasing use of ^{125}I as a tracer for thyroid function. However, some experiments published recently revealed that ^{125}I has a higher biological effect than would be expected from conventional dose evaluations. Detailed investigation of the mechanism of decay of ^{125}I showed that a significant portion of the energy is released by low-energy Auger electrons. The range of these low-energy electrons in tissue is small compared with the dimensions of a thyroid cell, thus giving rise to a non-uniform dose distribution within the individual thyroid cell. The cell nucleus is subject to a relatively weak radiation field, while at the cell-colloid interface it is about three times as high, depending on the actual dimensions of the cell and of the colloid in which the iodine is stored. Even this increase in local energy deposition to subcellular structures may not account for all the observed biological effects related to the incorporation of ^{125}I. The application of a quality factor for the low-energy Auger electrons, whose LET is significantly greater than 3.5 keV/μm, and the effects of multiple charged ions formed as a consequence of the Auger cascades may be of some biological importance. The contribution of Auger electrons to the radiation dose, which is usually neglected in conventional dosimetry (macrodosimetry), may be of special importance also for other radionuclides decaying mainly by electron capture. (auth)

33788 DIFFERENCES IN THE RADIOBIOLOGICAL ACTION OF ^{125}I AND ^{131}I IN THE THYROID CELL. Lewitus, Z.; Ben-Porath, M.; Feige, Y.; (and others) (Tel-Aviv Univ., Israel. Soreq Nuclear Research Centre, Yavne, Israel). pp 405-17 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The relative biological effectiveness (RBE) of different kinds of radiation has been established by comparison of survival curves, thus relating the quality factor to the lethal effect of radiation on the cell nuclei. These recommendations have been included in the 1954 ICRP report, but at this time they did not take into account the possible biological consequences elicited by the Auger electrons of radionuclides decaying by internal conversion. The renewed interest in the use of ^{125}I has stressed the importance of this problem. It was recently found that relatively small amounts of ^{125}I are able to induce a remission of thyrotoxicosis. It was concluded from these results that the radiobiological effect of a radionuclide is not only dependent on its physical properties, but also on the subcellular organization of the biological material with which it interacts. It is suggested that a new quality factor based on the influence of the radiation on the cellular protoplasm and not only on the nucleus should be introduced. (auth)

33789 DOSE DISTRIBUTION OBTAINED BY COMBINED ELECTRON AND PHOTON BEAMS. Gharbi, H. (Faculte de Medecine, Tunis); Dutreix, J. pp 461-80 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Study was limited to irradiation by 10 to 30 MeV electrons in association with high-energy photons (x rays produced by the same accelerator as the electrons, or cobalt-60 gamma rays) and to tissue thicknesses of 10 to 20 cm, i.e., depths at which practical radiotherapy problems occur. The results are presented so as to indicate the position and thickness of the "principal irradiation zone" in which the dose lies between 100 and 80% of the maximum dose (± 10% variation); the position and thickness of "harmful irradiation zones", where the dose is above 30% of the maximum dose; the position and thickness of zones where a dose representing between 50 and 80% of the maximum dose may in some cases be regarded as suitable for irradiation of certain additional areas; and a comparison with the depth-efficiency curves for electrons of energy above that of the electrons used in combination with photons. The numerical data given in the tables relate only to the dose distribution on the beam axis. They are inadequate for establishing dosimetric programs appropriate to a given patient, which require the usual corrections for surface irregularity and tissue heterogeneity. However, they should provide the basic elements — number of beams, nature and energy of radiation, relative contribution of the different beams — needed in routine clinical cases to establish the most appropriate treatment program for the particular clinical problem of the individual patient. (auth)

33790 RADIATION DOSE TO HUMANS FROM ^{75}Se-L-SELENOMETHIONINE. Lathrop, Katherine A. (Univ. of Chicago. Argonne Cancer Research Hospital, Chicago); Johnston, R. Eugene; Blau, Monte; Rothschild, Edmund O. J. Nucl. Med., Suppl.; 13: No. 6, 7-30(Apr 1972).

The radiation absorbed dose to humans from a single intravenous injection of ^{75}Se-L-selenomethionine was calculated. A summary of absorbed-dose estimates to various organs and the detailed absorbed doses are tabulated. (auth)

33791 CHOLANGIOCARCINOMA ASSOCIATED WITH THORIUM DIOXIDE (THOROTRAST): REPORT OF A CASE. Rota, Alexander N.; Weindling, Howard K.; Goodman, Paul G. (Sinai Hospital, Detroit). Mich. Med.; 70: 911-15(Oct 1971).

The case of a middle-aged patient with acquired idiopathic hemolytic anemia who, 12 years after an intravenous injection of thorium dioxide, developed cirrhosis and cholangiocarcinoma is described. (auth)

33792 RADIATION DOSE IN A HUMAN FETUS FOLLOWING USE OF ^{197}Hg. Sy, Wilfrido M. (Down-State Medical Center, Brooklyn); Rosen, Herman; Griffin, Nathaniel E.; (and others). Radiology; 103: No. 1, 139-41(Apr 1972).

The amount of radioactivity in the liver, lung, kidney, and heart of a human fetus was measured in the product of a cesarean hysterectomy twenty-four hours after the mother had received 200 μCi of ^{197}Hg. The results are tabulated, and an appendix gives the equations by which the organ-absorbed doses were calculated. (auth)

33793 EFFECTS OF LONG-TERM THOROTRAST EXPOSURE. Janower, Murray L.; Miettinen, Olli S.; Flynn, M. Jean (Massachusetts General Hospital, Boston. Harvard School of Public Health, Boston). Radiology; 103: No. 1, 13-20(Apr 1972).

Radiation related morbidity was evaluated in a follow-up study involving 724 patients who received Thorotrast for cerebral angiography and 315 control patients who underwent similar diagnostic examinations with use of nonradioactive media. Intensive clinical and laboratory examinations were conducted on 42 of the Thorotrast patients and 29 of the controls. In the Thorotrast series there were two cases of thorotrastoma, abnormalities in bromsulphalein and serum alkaline phosphatase values, a high frequency of chromosome aberrations, and one instance each of liver neoplasm, granulocytic leukemia, and nonalcoholic hepatic cirrhosis. Anemia, elevated white cell counts, and disturbances in red cell morphology were not found. (auth)

Animals

Refer also to abstracts 33649 and 33721.

33794 (AEC-tr-7303, pp 163-70) TISSUE DOSES IN THE CASE OF CHRONIC ADMINISTRATION OF TRITIUM OXIDE TO RABBITS. Serebryakov, N. G.; Chirkova, E. N. (Inst. of Transplantation of Organs and Tissues, Moscow). Translated from Radiobiologiya; 11: No. 3, 438-43(May-Jun 1971).

During the daily administration of tritium oxide (5 μCi/g) to healthy rabbits, there is an exponential increase in the absorbed dose rates in various organs and tissues. The investigated organs and tissues (nine items) have strictly individual ratios of the absorbed doses received on account of the β radiation of tritium incorporated into the dry residue and the tritium of water, both during chronic intake of HTO and after the end of its administration. A correspondence of the vulnerability of the tissues and organs not to the value of the local absorbed dose, but to the change in the percent tissue dose received on account of tritium incorporated into the dry residue, is observed. The most critical for tritium oxide of the investigated organs and tissues, according to the indices revealed, are the bone marrow and adrenals. (tr-auth)

33795 TIME SEQUENCE OF EVENTS IN HEPATOCYTES OF IRRADIATED AND NON-IRRADIATED LIVER. Tokin, I. B. (Inst. of Radiation Hygiene, Leningrad). Dokl. Akad. Nauk SSSR; 201: No. 2, 465-8(11 Nov 1971). (In Russian).

Biochemical events in hepatocytes, accompanied by corresponding ultra-structural reorganization, were studied in irradiated and non-irradiated liver. Male white mice were injected with ^{144}Ce chloride (200 μCi), and 45 days later the livers were examined for changes. The cell nuclei at all stages of regeneration in the irradiated livers was dense in comparison to cells of non-irradiated liver. The general character of changes in hepatocytes of irradiated liver was similar. (K.S.W.)

33796 GASTROINTESTINAL IRRADIATION OF SHEEP WITH AN INSOLUBLE ^{90}Y-TAGGED FALLOUT SIMULANT. Sasser, L. B.; Bell, M. C.; West, J. L. (Univ. of Tennessee, Oak Ridge). Health Phys.; 22: No. 5, 467-70(May 1972).

Sixteen 28-kg yearling wether lambs were fed 0, 45.7, 68.0, or 92.2 mCi of ^{90}Y-tagged fallout simulant (44-86 μ in diameter) during a 3-day period. The sheep were killed and necropsies performed after 15 days of clinical observation. Anorexia, diarrhea, pyrexia and loss of weight were the most prominent clinical signs. Anorexia appeared to be the most closely correlated early clinical indicator of radiation injury to the gastrointestinal tract: diarrhea and pyrexia were more variable. The most severe radiation damage observed at necropsy was in the ventral compartments of the rumen. Abomasal injury was rather superficial and only minor damage occurred throughout the remaining gastrointestinal tract. Nearly 100% of the ingested sand tagged with tracer ^{46}Sc was excreted by control sheep and sheep consuming the lowest level of ^{90}Y-tagged sand, but the sheep fed 68.0 and 92.2 mCi of ^{90}Y excreted only 82 and 62% of the dose, respectively. (UK)

33797 EFFECT OF GAMMA RADIATION ON THE PROTEIN METABOLISM Galarza, A.; Carriazo, D.; Feijoo, B. (Facultad de Farmacia, Madrid). Rev. Espan. Fisiol.; 27: No. 4, 283-7(Dec 1971). (In Spanish).

The effects of the gamma radiation on the blood proteins, albumins, globulins, fibrinogen, hemoglobin, urea, and free amino acids from various organs related with the blood composition (liver, spleen, kidney, lung, heart) were determined. Changes were observed in the blood protein concentrations; but do not think the drops were produced directly by the radiation. Albumins, fibrinogen, and hemoglobin decreased after the inoculation of 500 μCi/kg of $^{65}ZnCl_2$, while the globulins increased. The lowest hemoglobin concentration appeared immediately after the inoculation, with a maximum of ^{65}Zn in the organs, but fibrinogen and the albumins decreased slowly, with a minimum at 25 days. In this period, the ^{65}Zn concentration in the organs was very small. The free proteinogenic amino acids were not altered by the radiation. Delta aminolevulinic acid was the only amino acid that increased. It is a hemoglobin precursor, and it is possibly a Hb decrease-δ-ALA increase relationship. An increment of urea in blood was observed, but this increment coincided with a deficient elimination by urine. Because of this, it is thought that the urea elevation is not produced by a major catabolism of proteins. (auth)

33798 CONTAMINANTS IN ANIMAL PRODUCTS. I. MATHEMATICAL FORMULATION OF METABOLISM OF RADIONUCLIDES AND THE IMPORTANCE OF CONCENTRATION FACTORS C_f IN CALCULATING THE PERMISSIBLE CONCENTRATION OF CONTAMINANTS IN FEEDSTUFFS AND FOOD PRODUCTS. Dreusicke, M. (Bezirksinstitut fuer Veterinaerwesen, Potsdam, Ger.). Arch. Tierernaehr.; 20: No. 6, 497-508(1970). (In German).

A discussion is presented of terms used to characterize the metabolism of contaminants. Examples are given for its mathematical representation and the use of a table listing the concentration factors (C_f) of the radionuclides ^{131}I, ^{90}Sr, and ^{137}Cs is explained. In order to obtain the maximum permissible concentration of the nuclide in the daily diet the maximum permissible concentration of the radionuclide in the animal product has to be multiplied by the concentration factor. For calculating the maximum permissible concentration of non-radioactive contaminants in the daily diet and in the inhaled air of farm animals it is necessary to establish and list concentration factors (C_f). The advantages of such tables for industrial animal production are discussed. (auth)

33799 CONTAMINANTS IN ANIMAL PRODUCTS. II. CALCULATION OF MAXIMUM PERMISSIBLE CONCENTRATION OF CONTAMINANTS IN FEEDSTUFFS. Dreusicke, M. (Bezirksinstitut fuer Veterinaerwesen, Potsdam, Ger.). Arch. Tierernaehr.; 20: No. 6, 509-16(1970). (In German).

In communication I the application of the equation $T = C_f \cdot M$ (where T is the permissible maximum concentration of contaminants in the daily diet (feedstuffs + drinking water) of farm animals and M is the maximum permissible concentration of radionuclides in the animal product (foodstuff)) was described for radionuclides using a list of concentration factors (C_f). In the present report the range of application of T has been extended in such a way as to represent any combination of feed components containing varying amounts of contaminants so that the equation may be used to answer the following questions: What are the possible uses of the animal products as foodstuffs if the daily diet contains a contaminant that is present in a concentration T and if the maximum permissible concentration of contaminants (M) must not be exceeded? Which quantities of an arbitrary number m of n components in a daily diet may be present if the number of the other components (n – m) is known and a number of restrictive equations (m) is given, if the maximum permissible concentration of contaminants must not be exceeded and if definite requirements for the use of the animal product are made? (The concentration of contaminants in n components of the daily diet is given.) Which concentrations of contaminants in an arbitrary number m of n components in the daily diet may be present, if the concentration of contaminants in the other components (n – m) is known and a number of restrictive equations (m) is given, if the maximum permissible concentration of contaminants M in the animal product must not be exceeded and if definite requirements are made for the use of the animal product? The quantities of n components in the daily diet are given. Examples of these are given. Finally, the maximum permissible contamination of grazing land with the radionuclides ^{90}Sr, ^{131}I, and ^{137}Cs has been calculated for dairy cows. (auth)

33800 MODIFICATION OF THE HEPATOTOXIC ACTION OF ^{237}Np IN THE RAT. Mahlum, D. D. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Toxicol. Appl. Pharmacol.; 18: 696-702(Mar 1971).

Neptunium-237 is a hepatotoxin that dramatically increases lipid concentrations in female but not in male rats. The induction of fatty livers in female rats by ^{237}Np was ameliorated by adrenalectomy and hypophysectomy and by the administration of glucose, butylated hydroxytoluene, or nicotinic acid. Ovariectomy, thyroidectomy, or the administration of adenine, ATP, methionine plus choline, or testosterone offered no protection. Castration or injection of estradiol did not increase the susceptibility of males to ^{237}Np-induced fatty liver. Serum activities of ICD and GPT were also elevated by ^{237}Np administration, with the increases being greater in the females than in the males. These rises in ICD and GPT activities were prevented by adrenalectomy and hypophysectomy, but not by the administration of ATP, BHT, glucose, or nicotinic acid. (auth)

33801 RADIATION EFFECTS OF TRITIATED THYMIDINE STUDIED IN PREGNANT RATS AND THEIR OFFSPRING. Fliedner, T. M.; Chaudhuri, J.; Haas, R. J.; Knoerr-Gaertner, H.; Schreml, W. (Univ., Ulm, Ger.). pp 355-68 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB–286; CONF-710314.

Tritium is a radioactive nuclide which is becoming of increasing interest in radiation toxicology. The radiation effects of tritiated thymidine (^{3}H-TdR) on a number of cell renewal systems in developing and adult rats were investigated in order to establish dose-effect relationships. Tritiated thymidine was given by continuous intravenous infusion in one series of experiments to pregnant rats from day 9 of pregnancy until delivery. The ^{3}H-TdR doses studied were 1.6, 3.2, 4.8, 6.4 and 8.0 μCi/g/d. At the time of delivery, the offspring were investigated. The liver tissue was used to study the distribution of tritium in various biochemical fractions as a basis for dosimetric calculations. Liver cells were also used to investigate the incidence of chromosomal aberrations. The hemopoietic tissues, including blood, were used to study the radiation effects on the blood-cell forming elements and their regeneration. In addition, the radiation effects on the ovaries of the newborn rats were evaluated quantitatively. After it had been established that doses in excess of 1.6 μCi/g/d given to a pregnant rat not only produced significant morphological and functional alterations in the fetal tissue, but also a characteristic injury to the hemopoietic tissue of the pregnant animal itself, a study of tritiated thymidine toxicity, including electron microscopic investigations in adult rats was initiated. When 4.8 μCi/g/d was given for a total of 18 d to adult rats, a severe radiation syndrome was observed in the hematopoietic tissue. The observations led to the conclusions that the radiation damage produced by the continuous administration of ^{3}H-TdR varies greatly from organ to organ and the severity of the effect depends upon the stage of development of the animal. The effects of ^{3}H-TdR reported here justify a detailed investigation of the effects of other tritiated compounds, notably tritiated water, that are of relevance for modern technology. (auth)

33802 BIOLOGICAL TOXICITY ASSOCIATED WITH THE AUGER EFFECT. Feinendegen, L. E. (Kernforschungsanlage, Juelich, Ger.); Ertl, H. H.; Bond, V. P. pp 419-30 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB–286; CONF-710314.

A number of radioactive isotopes decay by the process of orbital electron capture, in which the unstable nucleus captures an electron from one of the innermost electron shells and becomes converted to an atom with chemical properties of the element one lower in the periodic table, e.g., ^{125}I becomes ^{125}Te. The daughter in the capture process is initially uncharged because the nuclear charge and the number of electrons are each reduced by one; however, the Auger effect then results in a cascade of electrons which fall to replace those lost in shells closer to the nucleus, and the ejection of electrons from the atom. By this process the still-intact atom may have a large number of holes in the outermost or valence shell, which are filled from other atoms of the molecule resulting in positive charges being distributed throughout that molecule. The positively charged atoms strongly repel each other by coulombic repulsion, and the molecule virtually explodes. The ^{125}I atom may achieve an electrical charge as high as +18. Although studies on the toxicity of DNA-bound-^{125}I on cell proliferation in mice are incomplete, there is evidence that the effects of the above process, at least when the ^{125}I is attached to DNA, may produce a degree of biological effect far in excess of that predicted on the basis of absorbed dose, and the factor involved may be between 10 and 20. The Auger electrons are of extremely short range and several are emitted simultaneously. Although the short-range electrons may be postulated to have an LET in excess of that of higher energy electrons or x rays, it is difficult to account for the high RBE on this basis. The simultaneous emission of several short-range electrons can result in an enormous energy density over a very small volume; however, it is difficult to predict the degree of possible effect on the basis of usual microdosimetric parameters such as LET, Y or Z. The entire added effect might be on the basis of the molecular explosion, in which event it might be regarded as less of a radiobiological phenomenon and more of a chemical effect. The effects of the process require additional study, particularly since elements that decay by orbital electron capture are finding increasing usefulness in nuclear medicine. (auth)

33803 ORIGIN OF URINARY TAURINE EXCRETION DURING CHRONIC RADIATION INJURY. Dilley, J. V. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res.; 50: No. 1, 191-6(Apr 1972).

Increased urinary taurine levels were observed in dogs that had a chronic lymphopenia for 2½ to 3 years after inhaling $^{239}PuO_2$ aerosols. A correlation between the onset of lymphopenia and increased taurine excretion was also noted in dogs within three months after inhaling $^{239}PuO_2$. Humans undergoing extracorporeal irradiation for the treatment of chronic lymphocytic leukemia demonstrated an increased urinary taurine level which correlated well with the reduction in the number of circulating lymphocytes. These data lend support to the hypothesis that the increased taurine excretion following chronic partial body irradiation originates from the destruction of circulating lymphocytes. (auth)

33804 RADIATION DAMAGE TO THE LIVER DURING INTERNAL IRRADIATION. Tokin, I. B. (Inst. of Radiation Hygiene, Leningrad). Arkh. Anat., Gistol. Embriol.; 57: No. 8, 23-36(1969). (In Russian).

Processes of injury and reparation of the rat hepatocytes after administration of 200 μCu of ^{144}Ce and 40 μCu of ^{137}Cs have been studied by means of qualitative (cytochemistry, etc.) and quantitative (morphometry) methods of light- and electronmicroscopy. Irradiation produced changes in correlations between different types of nuclei, diminutions in nucleo-nucleolar (by 40%) and nucleo-cytoplasmatic (by 20–30%) ratios, marked decrease in the surface volumes of the agranular and granular endoplasmic reticulum, injuries of mitochondria, micro-corpuscles and complex Golgi; the area of the specialized structures of the cellular surface underwent reduction; activity of ATP acid and alkaline phosphatases were lowered. Depth of primary radiation injuries correlated with the absorbed dose rate. The quantitative analysis allowed to discriminate reparative process from radiation effects. The most characteristic manifestation of the reparative processes is a marked increase (10.6 times relative to normal) of the agranular endoplasmic reticulum in the surface volume. Qualitative uniformity of radiation reactions of the cellular and subcellular structures has been shown. A conclusion has been drawn that radiation brought about dedifferentiation accompanied with a shift of biosynthesis from the extra- to the intracellular one. In determination of relative radiosensitivity of organoids there should be taken into consideration not only the depth of structural reconstructions, but also their reversibility, rate of reaction and importance of injuries for the life of the cell. On the basis of these principles a number of organoids might be arranged in the following order, with regard to decreasing radiosensitivity level lysosomes, mitochondria, endoplasmic reticulum, complex Golgi. Experience of application of some aspects of the principle of a hit to the supramolecular structures, i.e., cell organoids, has been demonstrated. Some arguments have been presented in favor of a possibility of qualifying lysosomes as "unique" structures an injury of which may become a decisive factor in the fate of the cells. Owing to a small number of organoids in the cell some other structural components of the latter (e.g., mitochondria) might be also referred to as "unique" ones. Hypothesis of inverse proportion in radiosensitivity of the cells and number of "unique" cytoplasmatic structures therein has been substantiated. (auth)

Plants

33805 (AEC-tr–7303, pp 206-10) INFLUENCE OF URANIUM ON THE YIELD OF SPRING WHEAT. Zhukov, B. I.; Zudilkin, N. V. Translated from Radiobiologiya; 11: No. 3, 466-9(May-Jun 1971).

The effects of uranium on the yield of spring wheat were studied under the conditions of greenhouse experiments. The absence of an effect was observed when uranium was introduced in an amount of 0.001% of the weight of the soil, and there was a significant inhibition of growth of the plants when the uranium concentration was increased to 0.005 to 0.01%. The influence of uranium on the yield of wheat varies depending on the type of soil and fertilizers introduced. (tr-auth)

Microorganisms

Refer also to abstract 33626.

33806 (COO–3023-3) LETHAL AND MUTAGENIC EFFECTS OF TRITIATED PURINES. ([Pennsylvania State Univ., University Park]). [1970]. 6p. Dep. NTIS.

Properties of a mutant (PS2) of Escherichia coli strain K12 are described. The mutant was labeled with guanine-8 ^{3}H or adenine-2,8 ^{3}H during exponential growth and the radioactivity was determined. Results are presented in the form of graphs. The data for survival were indistinguishable for the two labeled compounds. It was thought that the larger reversion frequency obtained using adenine-2,8 ^{3}H relative to that observed for guanine-8 ^{3}H was due to molecular rearrangements of adenine residues in DNA. The molecular rearrangements depend upon the relative amounts of adenine-2 ^{3}H and adenine-8 ^{3}H. This is determined by hydrolysis of DNA labeled with adenine-2,8 ^{3}H and determines the molar ratio of labeled adenine to guanine. Assuming equivalent labeling of adenine at the 2 and 8 positions a genetic coding efficiency per decay of about 0.05 to 0.10 was calculated. (H.L.W.)

33807 (COO-3419-1) BIOLOGICAL AND CHEMICAL STUDIES ON PHYSICAL MUTAGENS. Progress Report, April 1, 1971–March 31, 1972. Person, Stanley; Snipes, Wallace (Pennsylvania State Univ., University Park. Dept. of Biophysics). Contract AT(11-1)-3419. 4p. Dep. NTIS.

Progress is reported on studies on the effects of radiation and chemical mutagens on a strain of Escherichia coli K12 designated as PS2. Progress is reported in the following areas of research: mutagenic effects of ionizing radiation on base substitutions; repair of ultraviolet-induced mutations; use of ^{32}P and ^{33}P to induce mutations; mutagenic effects of ^{14}C-thymidine-2, ^{14}C-thymidine-methyl, and nitrogen mustard; suppressor mutations involving duplicate tRNA genes and altered UAA suppressors; and identification of amino acids inserted by suppressors. (H.L.W.)

Nuclide Kinetics and Toxicology

33808 (AEC-tr-7298) TRITIUM OXIDE. Moskalev, Yu. I. (ed.). Translation of Okis' Tritiya, Atomizdat, Moscow, 1968. 360p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 4881.

Man

Refer also to abstract 35667.

33809 (HASL-TM-70-7) RESPIRATORY TRACT DEPOSITION OF RADON DAUGHTERS IN HUMANS EXPOSED IN A URANIUM MINE (PHASE II). George, A. C.; Hinchliffe, L.; Epps, R. (New York Operations Office (AEC), N. Y. Health and Safety Lab.); Shepich, T. J. (Bureau of Mines, Denver, Colo.). 30 Oct 1970. 24p. Dep. NTIS.

Total respiratory deposition and nasal deposition of radon daughters were measured in human subjects in a uranium mine in several locations to obtain a variety of atmospheric conditions. Variables studied were fraction of uncombined radon daughter atoms, dust particle size and concentration, and respiratory tidal volume. Total respiratory deposition measured in three subjects in five locations ranged from 26% to 49% at a one liter tidal volume. Nasal deposition, measured in one subject, ranged from 5% to 10%. Both particle size and tidal volume were found to influence deposition. (auth)

33810 (LBL-775) MYOCARDIAL SCANNING WITH ^{82}Rb. Bokelman, Jonathan; Van Dyke, Donald; Yano, Yukio; Anger, Hal (California Univ., Berkeley. Lawrence Berkeley Lab.). Mar 1972. Contract W-7405-eng-48. 10p. Dep. NTIS.

The use of ^{82}Rb for obtaining definite myocardial images was demonstrated in seven animal species (rat, rabbit, monkey, dog, pig, goat, and chimpanzee), and experimentally produced infarctions in the dog were clearly delineated. Type or depth of anesthesia (some studies were done on unanesthetized dogs) was not a significant factor in myocardial visualization. Ten normal human subjects and six patients with myocardial disease failed to show clearly recognizable myocardial images. Severe exercise or increased dose of isotope did not aid in localizing the isotope in the myocardium. The difference in the handling of rubidium by the myocardium of man and by the myocardium of the 7 animal species is unexplained. (auth)

33811 (ORO-2401-44) RADIOISOTOPE STUDIES UTILIZING A LOW LEVEL WHOLE BODY COUNTER AND CLINICAL APPLICATIONS OF ACTIVATION ANALYSIS. Progress Report, 1971. Brill, A. B. (Vanderbilt Univ., Nasvhille, Tenn. Div. of Nuclear Medicine and Biophysics). 30 Apr 1972. 53p. Dep. NTIS.

The kinetics of ^{59}Fe distribution in normal man and in patients with erythropoietic disorders was measured by means of whole-body counting and radiometric analysis of blood samples during approximately 150 days following injection of a tracer dose. The kinetics of ^{206}Bi distribution in neoplastic and normal tissues of dogs was measured by analysis of tissue samples during 72 hours following injection. The content of ^{137}Cs in normal man during 1971 was measured by whole-body counting and results are compared with measurements made during 1959. The content of ^{137}Cs in human placental tissues sampled during 1971 was also measured. (C.H.)

33812 (ORO-2401-57) HUMAN FETAL RADIATION DOSE FROM ^{59}Fe ADMINISTERED TO THE MOTHER DURING PREGNANCY. Dyer, Norman Chandler (Vanderbilt Univ., Nashville, Tenn. Div. of Nuclear Medicine and Biophysics). May 1972. Contract AT(40-1)-2401. 228p. Dep. NTIS.

Thesis.

Data are reviewed from studies on the radiation dose distribution in human fetuses following administration of a tracer dose of ^{59}Fe to the pregnant mother. Results are reported from studies on the transport of ^{59}Fe from the pregnant mother to the fetus performed in women receiving therapeutic abortions. The transport kinetics of ^{55}Fe and ^{59}Fe to the fetus was measured following injection into pregnant sheep. The radiation dose distribution in the fetus was calculated at various times during gestation. (56 references.) (C.H.)

33813 (PNC-N-831-70-2, pp 89-90) BIOASSAY ASPECT FOR PLUTONIUM AT PNC. Hara, Teijiro; Motoyama, Shigeji; Tomita, Kazuo; Idesawa, Takahisa; Suzuki, Nobuo (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700227-2).

From fifth annual meeting of Japan Health Physics Society; Tokai, Japan (9 Feb 1970).

Results of bioassay for plutonium which have been carried out since January 1966 are summarized. For routine monitoring, 1,500 ml of worker's urine is collected at home to prevent contamination of the sample, and plutonium in the sample is separated with anion exchange resin and measured with a 2π gas flow counter. Frequency of the sampling ranges from quarterly to annually depending upon the exposure of the worker. Recovery of plutonium in the ion exchange method is 85 ± 14%. The results of analysis of approximately 1,300 urine samples showed that all samples were below the level of 0.2 pCi/1500 ml. Non-routine monitoring is carried out when plutonium content in urine exceeds the maximum permissible level, or when plutonium is ingested or inhaled by accident. Excreta and other biological samples are analyzed. In case of plutonium inhalation, fecal samples are collected for three or five days after intake. Fecal analysis were performed on 30 persons exposed to plutonium. Maximum total plutonium content was about 40 pCi in the samples for five consecutive days. Results showed that lung burden estimated with the lung model recommended by ICRP was less than one thousandth of the maximum permissible dose. (Japan)

33814 METABOLISM OF COBALT BY THE NORMAL HUMAN MALE: WHOLE BODY RETENTION AND RADIATION DOSIMETRY. Letourneau, E. G. (Dept. of National Health and Welfare, Ottawa); Jack, G. C.; McCullough, R. S.; Hollins, J. G. Health Phys.; 22: No. 5, 451-9(May 1972).

The whole body retention of cobalt after intravenous injection of carrier-free ^{58}CoCl$_2$ in saline solution was measured in 16 men. The retention data for each subject were analyzed statistically and the best descriptions of the data were provided by equations with five exponential terms. Investigation levels for the radioisotopes of cobalt were calculated for each subject. The average investigation level for ^{60}CoCl$_2$ computed from the data was an uptake of 1.2 μCi, which may be compared with the value of 24 μCi given in ICRP Publication 10. The coefficient of variation of the radiation dose to various members of the working population after a given uptake of radiocobalt was estimated to be 20%. (UK)

33815 ^{90}Sr IN TEETH. A COMPARISON OF METHODS. Rytoemaa, Inkeri; Paakkola, Olli (Univ. of Helsinki. Inst. of Radiation Physics, Helsinki). Acta Odontol. Scand.; 29: 321-6 (Sep 1971).

The results showed that analysis of the ^{90}Sr activity in teeth is possible with measurement of the Cérenkov radiation with an ordinary liquid scintillation counter. The results did not differ from those obtained by the more conventional technique based on the radiochemical separation of ^{90}Sr and measurement of the radioactivity with a low-background β-counter. The mean ^{90}Sr content in cow's teeth in Finland was 20.1 pCi/gCa. Gamma spectra and analyses for inactive components (x-ray fluorescence) in cow's and human teeth indicated further that utilization of Cérenkov radiation for the measurement of ^{90}Sr content in human teeth would not be disturbed by other radionuclides. (auth)

33816 PERMISSIBLE LEVELS OF TRITIUM IN MAN AND THE ENVIRONMENT. Osborne, R. V. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Radiat. Res.; 50: No. 1, 197-211(Apr 1972).

The physiological parameters needed for estimating the activity of tritium taken into the body from various tritiated environments are well established experimentally. Less certain is the relation of dose equivalent rate to body burden. A quality factor of unity appears reasonable. For chronic exposures to tritium, isotopic concentrations effects and transmutation effects are unimportant. The choice of body water as the critical organ is conservative since no tissue has a higher proportion of hydrogen. Recommended limiting levels for tritium in drinking water, in air, and in food are also conservative. For acute exposures, the main problem is estimating the dose equivalent from tritium bound to tissue components. One general analysis suggests an upper limit for this of 25% of the dose equivalent from tritium in body water. (auth)

33817 RADIONUCLIDES IN AUTOPSY SAMPLES FROM THOROTRAST PATIENTS. Goldin, A. S. (Northeastern Radiological Health Lab., Winchester, Mass.); Magno, P. J.; Geiger, F.; Janower, M. L. Health Phys.; 22: No. 5, 471-82(May 1972).

Results are presented for samples of tissues from two cases in the New England area, in which autopsies were performed on patients who had previously received injections of colloidal thorium dioxide. The first analyses, in each case, were performed about 24 hr post mortem. The concentrations of ^{228}Ra, ^{228}Th, ^{224}Ra, and ^{212}Pb were determined by repetitive gamma examination over a period from 24 hr to 30 days. The samples were then dissolved and the concentrations of ^{232}Th and ^{228}Th determined by radiochemistry. The data indicated that approximately 65% of ^{228}Ra, the first daughter of ^{232}Th, was eliminated from the body, that the parent ^{232}Th was translocated to bone, and that considerable quantities of ^{220}Rn were liberated to blood. The effects of these findings on dosimetry are discussed. The autopsy findings are compared with whole-body counting data, available on one of the patients. (UK)

33818 TRITIUM ACTIVITY IN URINE FROM LUMINOUS DIAL WRIST WATCHES. Fitzsimmons, C. K.; McNelis, D. N.; Wruble, D. T. (Western Environmental Research Lab., Las Vegas, Nev.). Health Phys.; 22: No. 5, 514-16(May 1972).

Although no increase in tritium was detected in the urine of 20 site residents during the natural gas flaring following the Rulison Event, concentrations up to 10 times the background were measured in persons wearing wrist watches with tritiated dials. The average tritium concentration in the urine of these 20 residents and two laboratory employees wearing tritium activated luminous dial watches was 3.4 nCi/l, ranging from 1.1 to 12 nCi/l. A person not wearing a watch had an average tritium concentration of 0.7 ± 0.2 nCi/l for a period over 9 months. The biological half-lives ranged from 7 to 21 days. (UK)

33819 PASSAGE OF ^{137}Cs FROM A FISH TO THE ULTIMATE SERVING DURING CULINARY PREPARATION. Pakulo, A. G. (Inst. of Biophysics, Moscow). Gig. Sanit.; No. 10, 49-51(Oct 1971). (In Russian).

The distribution of ^{137}Cs in the organs and tissues of fish and the proportion of the isotope removed during culinary preparation were studied. The muscles and the head contained 65% of the total ^{137}Cs; 16% of the total was removed during cleaning and removal of the scales, gills, and viscera. Cooking of the inedible parts of the fish (skin, head, fins) to form a broth removed the bulk of the ^{137}Cs contained in them. (K.S.W.)

33820 ^{210}Po IN THE HAIR, BONE TISSUE, AND LIVER OF MAN. Antonova, V. A. (Leningrad Scientific-Research Inst. of Radiation Safety). Gig. Sanit.; No. 10, 52-5(Oct 1971). (In Russian).

The distribution of ^{210}Po in the hair, bone tissues, and liver of man was studied by assaying 114 samples of hair, 71 samples of bone, and 46 samples of liver which were taken from both men and women. The subjects were residents of Leningrad, had died accidental deaths, and had not had previous contact with radioactive materials. The averaged respective concentrations of ^{210}Po in hair, bone tissue, and liver were (in pCi/kg) respectively: for men 156, 49, and 24; for women 138, 44, and 22. Scatter in the data amounted to from 6 to 10%. (K.S.W.)

Animals

Refer also to abstract 33794.

33821 (AEC-tr-7303, pp 154-62) CHRONIC ACCUMULATION OF TRITIUM IN THE ORGANS AND TISSUES OF HEALTHY RABBITS DURING DAILY ADMINISTRATION OF RADIOACTIVE WATER. Chirkova, E. N.; Serebryakov, N. G. (Inst. of Transplantation of Organs and Tissues, Moscow). Translated from Radiobiologiya; 11: No. 3, 431-7(May-Jun 1971).

During daily chronic administration of tritium oxide (0.005 Ci/g) to healthy rabbits, there is a sigmoid accumulation of tritium in the structural elements of the organism. The investigated organs and tissues of the rabbits (10 items) have strictly individual rates of increase in the specific activity, as well as rates of establishment and levels of dynamic equilibrium. The percent incorporation of tritium from the water of the organism into the dry residue of the organs and tissues is substantial in the case of chronic intake of radioactive water and must be taken into account in the determination of the critical organ for tritium. (tr-auth)

33822 LOCALIZED APPLICATION OF DNA PRECURSORS FOR STUDYING RADIATION EFFECTS IN CELL POPULATION KINETICS. Jenkinson, I. S.; George, S.; Paver, W. K. A. (St Vincent's Hospital, Sydney). pp 287-96 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

To avoid systemic administration of large doses of radioactive DNA precursors to patients, techniques have been developed for localized application of tritiated thymidine (^{3}H-TdR) and ^{125}I-iododeoxyuridine (^{125}I-IUdR). The latter has the advantage of gamma-ray emission whereby its uptake can be localized and measured externally, thereby avoiding the necessity for autoradiography. Autoradiographs of superficial Ehrlich tumors and adjacent tissues in mice have shown that single superficial injections of ^{3}H-TdR produce labeling of only isolated clumps of cells, suggesting non-uniform availability of ^{3}H-TdR around the injection site. The following methods of superficial application of 0.02-ml volumes of ^{3}H-TdR have been assessed: multiple superficial injections either within a short time or repeated at appropriate intervals; skin abrasion prior to surface application; injection of hyaluronidase prior to ^{3}H-TdR. Applications of 1 μCi TdR are sufficient to produce localized labeling, no labeling of cells distant from the injection site being evident. Similar methods proved successful for applying ^{125}I-iodo-deoxyuridine (^{125}I-IUdR) and confining it locally to superficial tissue. Within two days of application, the incorporation in tumor DNA approached its maximum, and thereafter the loss rate of radioactivity from the tumors was substantially the same as that of extractable ^{125}I-DNA. From these animal experiments it has been estimated that doses no greater than 100 μCi ^{125}I-IUdR may be used in superficial applications to human skin to provide sufficient ^{125}I-DNA activity for external localization and measurement over periods of several days to study cell population kinetics of basal cell carcinoma in individual patients. Similar doses of ^{3}H-TdR would be sufficient for autoradiographic studies. (auth)

33823 PREDICTION OF BIOLOGICAL DAMAGE FROM STOPPING POWER THEORY: ^{3}HTdR STUDIES. Davy, D. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp 343-53 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The carbon bond model is extended to cover cell death arising from the incorporation of tritium in cell nuclei. The initial assumptions are more specific than in previous formulations. The critical molecule becomes DNA and a semi-quantitative description of dose-rate effects is needed. Formulation within the above framework leads to the following conclusions for tritium incorporated in mammalian cell nuclei following the uptake of ^{3}H-thymidine: no dose-rate factor should be introduced in comparing LD_{50} values for external x rays and the dose arising from ^{3}H decay; little or no correction should be applied for the energy escaping the cell nucleus subsequent to a ^{3}H decay; the biological effect is independent of the size of the cell nucleus; about 50% of the total effect is due to the Auger effect; and transmutation accounts for about 10% of the total effect for cells irradiated at room temperature and about 40% for irradiations at liquid nitrogen temperatures. (auth)

33824 NEGATIVELY CHARGED AEROSOLS. EFFECT ON PULMONARY CLEARANCE OF INHALED $^{239}PuO_2$ IN RATS. Wehner, A. P. (Pacific Northwest Labs., Richland, Wash.). Contract AT(45-1)-1830. Chest (Chicago); 60: No. 5, 468-71 (Nov 1971).

Four-month-old female albino rats received a single 15 to 20 min nose-only exposure to $^{239}PuO_2$ dust (CMD 0.3μm). The animals were then randomly divided into experimental and control groups of 10, 12, and 18 rats each for three exploratory experiments. In experiments 1 and 2, the experimental rats were treated $3\frac{1}{2}$ hrs daily with negatively charged electro-aerosol (1 percent NaCl solution dispersed by a Küster–Barthel type aerosol generator, jet potential −26 kV, MMD of aerosol particles 3.8μm) and killed after three weeks. In experiment 3, the experimental rats were treated continuously with electro-aerosol and killed in groups of six after 5, 24, and 48 hrs respectively. After death, the lungs were removed and analyzed for ^{239}Pu. With the exception of the subgroup killed after 24 hrs, the mean lung burden of ^{239}Pu was from 8 to 34% lower in the animals treated with electroaerosol than in the controls treated with uncharged aerosol and those not treated with aerosol. (auth)

33825 UPTAKE OF $^{56\ 57\ 58}$Co AND ^{65}Zn BY MARINE BENTHIC ORGANISMS. Zavodnik, N.; Hrs-Brenko, M. Bull. Sci. Cons. Acad. Sci. Arts RSF Yougoslavie, Sect. A; 14: 5-6, 146-7(1969).

The fallout contamination rate of small animals and fish living on the sea bottom was investigated with a laboratory model. The uptake of radionuclides was different for various species. It was higher in the worm Sternaspsis scutata than in other bottom dwellers. The various genera of the same systematic group react differently towards the radionuclides, e.g., the uptake of almost all shellfish studied was very low while the uptake of Nucula was considerably greater. Contamination rate is greatest in those parts of the body directly in contact with the sea bottom. (auth)

33826 INFLUENCE OF COLD ON RADIOSTRONTIUM EXCRETION. Wedin, B.; Nilsson, A.; Roennbaech, C. (Research Inst. of National Defence, Sundbyberg, Sweden). Nature (London) New Biol.; 236: No. 68, 212-13(19 Apr 1972).

Murine excretion of radiostrontium was studied in relation to the temperature of the environment for up to 30 days after intraperitoneal injection at room temperature of about 1 μCi ^{85}Sr in the form of chloride solution. Results showed an acceleration rate of cold on radiostronium excretion down to 9°C. Animals placed in temperatures of 4°C after injection did not show an enhanced effect compared with animals in the 9°C group, but decreasing the temperature from 9°C to 4°C over a period of 10 days caused a more intense excretion rate than those placed in a constant temperature of 9°C immediately after administration of radiostrontium. Excretion rates ultimately followed the same pattern if the lower temperature were delayed by 24 hr, although retention for 1 day after injection was the same as that of the control animals. (UK)

33827 COMPARISON OF FECAL EXCRETIONS OF ^{46}Sc TAGGED SAND AND SOLUBLE ^{144}Ce BY CALVES. Miller, J. K.; Byrne, W. F.; Lyke, W. A. (Univ. of Tennessee, Oak Ridge). Health Phys.; 22: No. 5, 461-5(May 1972).

Effects of physical form of radioactive material on its retention in the calf digestive tract was investigated in two trials. ^{144}Ce^{144}Pr as the chloride and ^{46}Sc tagged 44 to 86 μ diameter sand were simultaneously administered orally to each of six calves averaging 150 kg. Feces were weighed and sampled for 7 days. During this period, five calves excreted 96% of the administered ^{144}Ce^{144}Pr but only 89% of the ^{46}Sc-sand. Time required for 50% recovery averaged 39 hr for ^{144}Ce^{144}Pr and 61 hr for ^{46}Sc-sand. The sixth calf, which ate only 32% as much hay as the average of the other five, excreted only 87% of the ^{144}Ce^{144}Pr and 60% of the ^{46}Sc-sand during the 7 days. ^{144}Ce^{144}Pr as the chloride and 88 to 176 μ tagged sand were simultaneously administered orally to each of five calves in a second comparison. The fecal excretion pattern of radiocerium was almost identical to that of the first trial but time required for excretions of various fractions of the 88 to 176 μ sand averaged 70% longer than corresponding recovery time for the 44 to 86 μ sand. Recovery of the larger diameter sand averaged only 89% at 312 hr after oral administration. These results suggest the nature of gastrointestinal radiation damage following ingestion of a radioactive material could be influenced by the physical form of the radioactivity. (UK)

33828 PULMONARY LAVAGE: THERAPY OF PULMONARY CONTAMINATION BY PLUTONIUM OXIDE. Kunzle-Lutz, M. (Centre d'Etudes, Bruyeres-le-Chatel, France); Metiveer, H.; Nolibe, D.; (and others). J. Eur. Toxicol.; 4: No. 1, 53-9(Jan-Feb 1971). (In French).

The pulmonary lavage in vivo by saline solutions was tested with monkeys previously dusted over with plutonium oxide. The animals underwent 1, 3, or 5 series of washings of the lower right lobe; each session consisted of 5 to 10 repeated irrigations. The results obtained indicate the following: it is useless to carry out more than 6 irrigations during any one session; maximum efficiency is obtained when the treatment is carried out within the first few days immediately following the dusting; and whereas one session eliminates 10% of the dust particles in the area treated, several sessions lower the pulmonary amount in the treated area from 45 to 55%. Repeated treatment is therefore recommended. (auth)

Plants

33829 FORMS OF CALCIUM IN SOILS AND ^{90}Sr CONTENT IN GRAIN CROPS. Ivanov, S. N.; Shagalova, E. D.; Shifrina, S. S. Dokl. Akad. Nauk BSSR; 15: No. 11, 1031-3(Nov 1971). (In Russian).

The Ca contained in soil has a definite effect on the uptake of ^{90}Sr by agricultural plants used for production of grain. A well-defined correlation exists between the ^{90}Sr content in plants and the content of exchangeable Ca in soil. Such a relation does not exist between ^{90}Sr and the acid-soluble Ca in a soil. Thus, for the ^{90}Sr content of a plant product such as grain, expressed in strontium units, the quantity of exchangeable Ca in the soil is the decisive factor. (tr-auth)

Microorganisms

33830 EFFECT OF SMALL CONCENTRATIONS OF DEUTERIUM OXIDE ON THE GROWTH OF INTESTINAL BACTERIA. Popov, Yu. B. (Khabarovsk Medical Inst., USSR). Gig. Sanit.; No. 1, 116-17(Jan 1972). (In Russian).

The effect of heavy water, as compared with natural water, on the early stages of growth of intestinal bacteria was studied. A culture of Escherichia coli was treated with the following concentrations of D_2O while growing on typical medium: 0.0147, 0.0197, 0.0247, 0.0307, and 0.0347%. No effect on the initial stages of bacterial growth could be observed at these low concentrations. (K.S.W.)

New Tracer Techniques

33831 PROCEDURE FOR SIMULTANEOUS DETERMINATION OF SECRETION RATES OF DEOXYCORTICOSTERONE AND CORTICOSTERONE BY DOUBLE-ISOTOPE DERIVATIVE ASSAY. Seth, K.; Nowaczynski, W.; Kuchel, O.; Mancheno-Rico, E.; Genest, J. (Clinical Research Inst., Montreal. Hotel-Dieu Hospital, Montreal). Can J. Biochem.; 50: No. 2, 136-41(Feb 1972).

A procedure for the simultaneous determination of secretion rates (S.R.) of deoxycorticosterone (DOC) and corticosterone (B) by double-isotope derivative assay is described. In a detailed assessment of the method the importance of careful purification and isolation of the metabolites of both steroids is emphasized. The S.R. of DOC was 174.6 ± 14.6 S.E. μg/14 h in 19 determinations in 15 normal controls and 7712 ± 2072 S.E. in three determinations after metapyron administration. Corticosterone S.R. was 2778 ± 232 S.E. μg/24 h in 15 determinations in 12 normal controls. All the experiments were done on normal sodium intake. (auth)

33832 TECHNOLOGY AND INTERPRETATION OF NUCLEAR MEDICINE PROCEDURES. Sodee, D. Bruce; Early, Paul J. St. Louis; C. V. Mosby Company (1972). 526p. $22.90.

This procedural manual is divided into two parts: Nuclear Science and Clinical Nuclear Medicine. Part I, Nuclear Science, is a laboratory manual containing treatment and exercises of many of the principles basic to nuclear instrumentation, radiochemistry, and health physics. These exercises are designed to help the novice technologist to better understand the various aspects of nuclear medicine. Part II, Clinical Nuclear Medicine, is a procedural manual containing the physiologic principles and the interpretation of nuclear medicine procedures for those who practice in the field of nuclear medicine or refer patients for nuclear medicine evaluation. The procedural steps and interpretations represent current methodology. (C.H.)

33833 PRINCIPLES OF THE USE OF RADIO-ISOTOPE TRACERS IN CLINICAL AND RESEARCH INVESTIGATIONS. Oliver, R. Oxford; Pergamon Press (1971). 107p. £ 1.50.

The subject is dealt with under the headings: atomic physics, radioactivity and radioactive isotopes, the measurement of activity of radioactive material, the use of radioactive isotopes in clinical diagnostic tests and research, and radiation hazards and protection. Appendices showing the periodic table and maximum permissible annual ingestion of radio-nuclides are given. (UK)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 33123, 33185, 33191, 33211, 33901, 33909, 33940–33942, 33964, 33977, 35238, 35251, 35307, 35308, 35328, 35333, 35435, and 35438.

33834 (AAEC/LIB/Bib–333) ZIRCONIUM–URANIUM OXIDE SYSTEMS WITH OR WITHOUT CALCIUM. A Bibliography. Literature Search Covers the Period 1962–1971. Geue, Jean (comp.) (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1972. 34p. Dep. NTIS (U. S. Sales Only).

Forty nine references with citations of abstracts are listed covering the years 1948 to 1970. Arrangement is chronological and alphabetical within each year. (Australia)

33835 (BMBW-FBK–71-17, pp 10.1-16) REPORT ON THE PROTACTINIUM–OXYGEN SYSTEM. Knoch, W.; Schieferdecker, B. (Gesellschaft zur Wiederaufarbeitung von Kernbrennstoffen m.b.H., Leopoldshafen bein Karlsruhe (West Germany)). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Starting with ^{205}Pa in a reducing atmosphere, new Pa-O-phases or mixtures of oxides were obtained through stepwise temperature increases. To maintain a desired oxygen partial pressure, a mixture of H_2H_2O was conducted through the heating area. Composition of the Pa-O-phases were tabulated as a function of temperature. Complete reduction of Pa_2O_5 to PaO_2 was not possible with the applied method. (H.B.G.)

33836 (BMBW-FBK–71-17, pp 15.1-14) PREPARATION AND IDENTIFICATION OF Pa CARBIDES. Lorenz, R. (Technische Universitaet, Brunswick (West Germany)); Scherff, H. L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Studies were made on the preparation and chemical and structural properties of protactinium carbide. Information on the thermodynamic stability of the oxide was obtained from a study of the CO-equilibrium pressures of the reaction. The reaction of a pelletized mixture of C and Pa_2O_5 was found to proceed in two steps, the first one involving reduction of the pentoxide to the dioxide and the second one corresponding to the carbide forming reaction according to $PaO_2 + xC = Pa_{x-2} + 2CO$. X-ray diagrams obtained from 1950°C runs showed only one fcc phase with a lattice parameter of 5.0608 ± 0.0002 Å. By calculating the relative intensities of the (111) and (200) reflections it was found that the protactinium monocarbide forms a structure of the NaCl-type, like the other actinide monocarbides. (P.C.H.)

33837 (DRI–2084) INVESTIGATION OF HYDRIDING PARAMETERS. Quarterly Progress Report. Sullivan, Richard W. (Denver Research Inst., Colo.). 11 Feb 1963. Contract AT(11-1)-1092. 10p. Dep. NTIS.

Declassified 27 Oct 1971.

Results of studies are presented on the effects of minor alloy additions and hydriding cycle variations on the hydriding behavior and brittleness of delta and epsilon hydrides of Zr. (J.R.D.)

33838 (DRI–2194) PHASE DIAGRAM STUDY OF THE BeO–Y_2O_3–ZrO_2 SYSTEM IN REDUCING ATMOSPHERES. Final Report. Otto, Henry E.; Bobeck, Gene E.; Lundin, Charles E. (Denver Research Inst., Colo.). Sep 1964. Contract AT(11-1)-1092. 55p. Dep. NTIS.

Declassified 28 Oct 1971.

The BeO-rich portion of the BeO–Y_2O_3–ZrO_2 system was investigated in reducing atmospheres. A necessary part of this investigation was a study of the binary system BeO–Y_2O_3. One compound was established in the BeO–Y_2O_3 system that occurs at a composition of 2BeO: 1Y_2O_3 and between about 1600°C (2912°F) and 1575°C (2865°F). This compound, which has orthorhombic symmetry, decomposes on cooling to form BeO and Y_2O_3. Three principal phase regions were found in the BeO-rich portion of the ternary system at room temperature. These regions were BeO + Y_2O_3, BeO + Y_2O_3 + face-centered-cubic phase, and BeO + face-centered-cubic phase. The face-centered-cubic phase was typical of stabilized zirconia having the fluorite-type structure. On heating, the above phase regions were present up to about 1575°C (2865°F) at which time the orthorhombic phase occurred in the phase region that previously contained BeO and Y_2O_3. Above 1580°C (2875°F), a liquid phase was present adjacent to the BeO–Y_2O_3 system. The monoclinic and tetragonal modification of ZrO_2 was not detected in the ternary system at Y_2O_3 compositions in excess of one mole percent. Heating selected specimens in air had no effect upon the phases present, but some lattice expansion of the Y_2O_3 and face-centered-cubic phases was noted. (auth)

33839 (GE-TM–66-4-18) HIGH TEMPERATURE LONG-TIME IRRADIATION EFFECT ON REFRACTORY-METAL-CLAD FUEL ELEMENTS. Newsom, D. L.; Danforth, R. H. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). 1966. Contract AT(40-1)-2847. 26p. (CONF-660608–14). Dep. NTIS.

From second AIAA Propulsion Joint Specialist conference; Colorado Springs, Colo. (13 Jun 1966).

Fuel element material systems of refractory metal clad W–UO_2–ThO_2 and Mo–UO_2 dispersion-type elements were evaluated by high-temperature long-time in-pile testing. The investigations included the effects of irradiation on physical integrity, microstructure, and fission product retention capabilities at temperatures of 1650 to 2000°C for periods up to 3085 hours and burnups to 1 percent. The test specimens were cylindrical, single-hole fuel elements with cores of enriched UO_2 dispersed in a metal matrix, clad with high quality components bonded by a high-temperature gas pressure technique. Testing was performed in the LITR reactor at ORNL while preparation of the cartridge, test specimens, and post-test evaluations were conducted at GE-NMPO. Four separate in-pile tests were conducted to evaluate three fuel element systems (Ta-clad W–UO_2–ThO_2, W–Re–Mo clad W–UO_2–ThO_2, and Nb-clad Mo–UO_2). (auth)

33840 (IAEA-TA–527) FUEL ELEMENTS TESTING. Report to the Government of Argentina. Hess, E. G. (International Atomic Energy Agency, Vienna (Austria)). 24 Mar 1970. 5p. INIS.

Methods used in programs to advise on the planning of work and to specify the tests to be carried out on power reactor fuel elements of the UO_2-Zircaloy-type are described. The general philosophy and basic specifications of a pressurized water out-of-pile loop for testing full-size Atucha fuel elements and a program of metallurgical research on the influence of fabrication techniques on the properties of Zircaloy and related alloys including equipment for testing and evaluating Zircaloy properties are discussed. (INIS)

33841 (IEA–257) ACTUAL STATE OF TECHNOLOGICAL DEVELOPMENT OF NUCLEAR FUELS AT THE ATOMIC ENERGY INSTITUTE. de Souza Santos, Tharcisio D.; de Freitas, Clauer Trench; Haydt, Heliton Mota; Gentile, Erberto Francisco; Ambrozio Filho, Francisco (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec 1971. 13p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

Translated from Metalurgia (Sao Paulo); 27: No. 168, 791-800 (Nov 1971).

The development of fuel element technology for high-flux reactors and for future power reactors with UO_2 pellets is discussed. The plastic behavior of fuel assemblies during hot-rolling of welded picture frame sets and of cast clad ingots was studied, much attention having been given to cast clad ingots of special design. The cast cladding affords excellent bonding, as evaluated by the resistance of the finished plates in a reverse bending test. The results on the sinterability of nonstoichiometric UO_2 powders produced for the utilization in UO_2 pellet fabrication are discussed. Further developments on a new pilot plant for ceramic studies and for a special materials laboratory are also presented. (auth)

33842 (KFK–1540) PREPARATION OF SULFUR-MODIFIED URANIUM CARBIDE. Korogiannakis, P.; Wedemeyer, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Jan 1972. 38p. (In German). Dep. NTIS (U. S. Sales Only).

With regard to a possible better compatibility behavior of nuclear carbide fuels containing uranium sulfide, the preparation of uranium carbosulfides containing 1 to 4 wt% uranium monosulfide was developed. A method for preparation of uranium oxysulfide from the reaction of uranium dioxide and carbon disulfide is described and an activation energy of 74.2 ± 0.5 kcal/mol was determined. The carbothermic reduction of uranium oxysulfide to pure uranium monosulfide was possible within the range from 1350 to 1400°C; above 1400°C the uranium oxysulfide slowly decomposed into uranium dioxide and uranium disulfide. The preparation of uranium carbosulfides by melting the pure components in an arc furnace under argon was easily realized. More propitious in technological fabrication seemed to be the carbothermic reduction of uranium dioxide together with uranium oxysulfide. When taking pure UOS no reasonable result was obtained after short times of reduction (i.e., 5h) in spite of the small amounts of oxysulfide in the reduction mixture. However, when taking partially reduced uranium oxysulfide, uranium carbosulfide was obtained with oxygen impurities of about 1000 ppM after reduction times of 5 h at 1380°C and 3 h at 1850°C. (auth)

33843 (LA-4913) QUARTERLY STATUS REPORT ON THE ADVANCED PLUTONIUM FUELS PROGRAM, OCTOBER 1–DECEMBER 31, 1971. Baker, R. D. (comp.) (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 27p. Dep. NTIS.

Activities in programs directed to examination of radiation effects on LMFBR fuel materials are reported. Research results are reported on ceramic Pu fuels and standards for fast breeder oxide fuels. (J.R.D.)

33844 (ORNL-TM-3441) IRRADIATION OF PYROLYTIC-CARBON-COATED FUEL PARTICLES TO FAST FLUENCES SIGNIFICANT FOR HTGR'S. Hewette II, D. M.; Coobs, J. H.; Scott, J. L.; Conlin, J. A.; Senn, R. L. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 21p. Dep. NTIS.

Seventeen sample types consisting of coated ThO_2 particles were irradiated in the High Flux Isotope Reactor target region to fast-neutron fluences up to 7×10^{21} neutrons/cm^2 (>0.18 MeV). One set of each type was tested at about 700°C and another at 1100°C. All particles irradiated at the lower temperatures survived. All isotropic coatings survived regardless of density and crystallite size within the limits of 1.74 to 2.06 g/cm^3 and 30 to 160 Å. All nearly isotropic (BAF = 1.1) coatings survived if they had a density of 1.81 g/cm^3, but failed if they had a density of 2.1. Two sample types contained a SiC intermediate barrier layer. At 1100°C such a particle survived with an outer layer having a density of 1.81 g/cm^3 and a BAF = 1 but failed with an outer layer having a density of 2.06 g/cm^3 and a BAF = 1.3. (auth)

33845 (PNC-N-831-70-2) SEMI-ANNUAL PROGRESS REPORT OF POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION, TOKAI WORKS, JANUARY–JUNE 1970. (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. vp. Dep. NTIS (U. S. Sales Only).

A separate abstract was prepared for each of the 17 sections of the report. (M.C.G.)

For abstracts of individual sections see: 33092, 33244–33247, 33301, 33325, 33342, 33813, 33846–33852, and 33895.

33846 (PNC-N-831-70-2, pp 1-10) SOL-GEL PROCESS DEVELOPMENT IN JAPAN. Nakamura, Yasuji; Suzuki, Susumu; Tsunoda, Naomi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970.

Sol-gel processes for the preparation of dense and coarse UO_2 and PuO_2-UO_2 shards that can be used for vibratory compaction were developed. The process established produced products having satisfactory characteristics for the vibratory compacted reactor fuels. A series of capsule irradiation tests was performed, and also an assembly of 3 × 3 fuels was successfully irradiated in Halden Boiling Water Reactor. Post-irradiation tests of these irradiated fuels are proceeding and some results have shown that the sol-gel fuels have promising performance. About 20 kg of 3.1% PuO_2-UO_2 sol-gel fuel was prepared without any difficulty in the process operation. (auth) (Japan)

33847 (PNC-N-831-70-2, pp 11-14) PREPARATION OF URANIUM CARBIDE AND ITS PELLET FABRICATION. Naruki, Kaoru; Narita, Daisuke; Takanobu, Osamu; Muto, Tadashi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-1).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Efforts for the preparation of carbide fuels were directed to develop carbothermic reduction, cold pressing, and sintering methods to prepare uranium carbide pellets. The effect of binder for consolidation of UO_2-C powder blend was investigated. The PVA binder resulted in an increase of carbon content of the carbide. This may be due to carbon contribution from the binder. Crushing and extended heat treatment at low temperature resulted in removal of the binder from pellets. Other binders were compared on fabricability of green pellets. It was difficult to tell superiority between them from their sintered density. Experiments were conducted on comminution of carbide granules as prepared by the carbothermic reduction. The experiment revealed that wet ball milling with CCl_4 was more effective than dry ball milling when a vibratory mill was used. The wet ball milled powder gave higher sintered density in spite of a little larger particle size than the dry ball milled powder. (Japan)

33848 (PNC-N-831-70-2, pp 15-34) GETR-S SCREENING IRRADIATION TEST FINAL REPORT. Koizumi, Masumichi; Matsumoto, Kenichi; Yokouchi, Yoji; Terunuma, Toshihiro; Hayashi, Hiroshi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-2).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Four PuO_2-UO_2 fuel pins (two containing pellet fuel and two containing vipac powder fuel) were fabricated and irradiated to nominal burnups of 1,000 to 1,300 MWD/Te. Metallography examinations were performed to estimate the axial distributions of metallographic structure changes. The metallographic and irradiation conditions were analyzed to explain the fuel performance. (auth) (Japan)

33849 (PNC-N-831-70-2, pp 35-45) IN-PILE FISSION GAS RELEASE FROM UC AROUND $2,000^0$C. Furuya, Hirotaka; Komatsu, Junji; Muto, Tadashi; Doi, Akira; Inoue, Kiyoshi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-3).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

In-pile fission gas release from nearly stoichiometric sintered uranium monocarbide was measured in the temperature range 1,650 to 2,030°C. The results were analyzed by the diffusion model. The diffusion coefficient of krypton in uranium monocarbide was expressed by the following equation: $D = 1.6 \times 10^{-7} \exp [-(56,400)/(RT)]$ cm^2/sec. These values were compared with the results obtained with uranium dioxide in the same irradiation facility. (auth) (Japan)

33850 (PNC-N-831-70-2, pp 46-8) SOME CONSIDERATION ON THE BEHAVIOR OF Ba, Sr, AND Zr IN UO_2. Noro, Kenji; Shiraishi, Satoshi; Satoh, Masakazu; Masuyama, Sadakichi; Koizumi, Masumichi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-4).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Studies were made on fission products that make new phases in the oxide fuel matrix and on pseudo-fission products, namely Ba, Sr, and Zr in UO_2, by means of high-temperature x-ray diffraction and electron microprobe analysis. It was found that two kinds of reaction products were formed in a mixture of UO_2, BaO, SrO, and ZrO_2 powders after heat treatment at 1,500°C for 30 minutes. These compounds were crystallographically determined as (Ba, Sr)UO_3 and (Ba, Sr)ZrO_3. Both compounds had same crystal structure as perovskite ($CaTiO_3$), and the lattice parameters varied with barium and strontium contents in the compounds. A mixture of UO_2, ZrO_2, BaO, and SrO was blended and pressed at 1.5 ton/cm^2 and then sintered at 2,000°C for 1 hour in He containing 5% H_2. The electron microprobe analysis indicated that Ba, Sr, and Zr were present as oxides in UO_2. Ba, Sr, and Zr also made a compound (Ba, Sr)ZrO_3. Ba, Sr, and UO_2 made a compound (Ba, Sr)UO_3 in equiaxial grain region. This compound decomposed in the columnar grain region and Ba and Sr diffused toward colder region. Lattice parameters of the system at 1,500°C were tabulated. (Japan)

33851 (PNC-N-831-70-2, pp 49-53) EFFECT OF SOLID FISSION PRODUCTS ON THE LATTICE PARAMETER OF (U,Pu)O_2. Satoh, Masakazu; Masuyama, Sadakichi; Koizumi, Masumichi; Noro, Kenji; Shiraishi, Satoshi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-5).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Lattice parameter changes occur with increasing accumulation of solid fission products in (U, Pu)O_2. The parameter change due to these fission product elements was investigated with nonradioactive pseudo-fission product elements. Pellets were prepared from $UO_2-20\%$ PuO_2 powder blended with oxide powder of inactive fission product elements. This was presintered at 650°C for 8 hours in $N_2-5\%H_2$, and sintered at 1600°C for 2 hours, and then heated at 2200°C in a molybdenum tube containing He gas. A part of the pellets was examined with an x-ray diffractometer. The lattice parameters of the sample containing the pseudo-fission products decreased with increasing content of the solid fission products. However, for UO_2 pellets containing the fission products, the lattice parameters of each solid solution of oxide of the fission products and UO_2 were in good agreement with literature values, but the change of lattice parameters was not observed. Mean lattice parameters of simulated materials were calculated from individual parameter values for the solid solution of the oxide of fission product elements and UO_2. These calculated values were in good agreement with experimental results. (Japan)

33852 (PNC-N–831-70-2, pp 54-8) OXIDATION BEHAVIOR OF UO_2–PuO_2 MIXED OXIDE. Satoh, Masakazu; Okubo, Tadabumi; Ishikawa, Eiichi; Matsumoto, Kenichi (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345–6).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Thermogravimetric studies of oxidation of mechanically blended UO_2−18% PuO_2 pellets were carried out to determine whether or not the pellets are broken into powder by oxidation in air. UO_2 pellets are pulverized easily by oxidation, but PuO_2 does not absorb further oxygen into the crystal lattice. UO_2 and PuO_2 powders were blended, and ball milled to 200 mesh for 4 hours. This blended powder was pressed and sintered in N_2−5% H_2 at 1,600°C for 2 hours. As reference samples, pure UO_2 pellets were examined. The pellets were put into a platinum tube and oxidized in air at various temperatures. The B.E.T. method was employed to determine surface area of pulverized samples. At 360°C, the weight increase was 27.4 mg per 1 g of the sample and it was broken into powder, while at 310°C the pellets scarcely increased their weight and held their shape. Below 465°C the sample weight increased with oxidation temperature. Effect of oxidation temperature rise disappeared above 465°C. The pure UO_2 pellets increased weight by 41.5 mg per 1 g of the sample. The surface area decreased with increasing oxidation temperature. Reduced powder was pressed into pellets under pressure, and sintered in N_2−5% H_2 gas at 1,600°C for 2 hours. Density of the pellets obtained was about 77% T.D. (Japan)

33853 REGULARITIES OF ZIRCONIUM DIBORIDE GRINDING. D'yakonova, L. V.; Kislyi, P. S. (Inst. of Problems in Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 1-5(Jan 1972). (In Russian).

The kinetics of zirconium diboride powder grinding in a vibrating mill were investigated. Particle sizes were determined by microscopic and sedimentary analyses and by the ratio of gas flows. Optimum time of dispersion was also determined. The gas flow ratio method gave the most reliable data on the average size of particles. (auth)

33854 METHOD OF MANUFACTURING COMPOSITE GRAPHITE–PYROCARBON–SILICON CARBIDE OR SILICON BASED CARBIDE MATERIALS. Couach, Michel (to Commissariat a l'Energie Atomique). French Patent 2,068,160. 26 Jul 1971. Filed 28 Nov 1969. (In French).

A method for manufacturing graphite−pyrocarbon−silicon carbide/silicon based carbide composite materials is described. The process consists of bringing a carbon containing material with a density between 1.4 and 1.5 g/cm^3 to a temperature between 1500 and 1700°C, immersing the material in a Si bath, and putting the impregnated material in contact with a very porous graphite material in order to eliminate the excess of free silicon. (France)

33855 FRICTIONAL CHARACTERISTICS OF OXIDE-TREATED AND UNTREATED TUNGSTEN–CARBIDE TOOLS. Suh, N. P. (Massachusetts Inst. of Tech., Cambridge); Sanghvi, B. J. J. Eng. Ind.; 93: No. 2, 455-60(May 1971).

The role of surface oxide layers in the tungsten carbide tool wear was investigated by treating the tools with titanium dioxide and by performing friction tests. The friction tests were performed using both the oxide-treated and untreated tools at various temperatures, loads, and sliding speeds. The oxide-treated tools were prepared by coating tungsten carbide tools with titanium dioxide and heating them to temperatures above 1525°F in a vacuum of 10^{-4} torr to induce mass diffusion. The oxide-treated tools which contained titanium, tantalum, and niobium in addition to tungsten carbide and cobalt had higher hardness and lower coefficient of friction, especially at high temperatures. Structural changes took place at the subsurface layer during the oxide treatment, which lowered the coefficients of friction of the tool and enhanced the steel cutting properties of tungsten carbide tools. (auth)

33856 NEW TERNARY BORIDES WITH A STRUCTURE OF THE $YCrB_4$ TYPE. Kuz'ma, Yu. B.; Svarichevskaya, S. I. (Lvov State Univ.). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 2, 166-9(Feb 1972). (In Ukrainian).

The new $RMeB_4$ (R = Y, Gd, Tb, Dy, Ho, or Er; Me = Mo, W, or Re) and $TmCrB_4$ compounds with the orthorhombic structure of the $YCrB_4$ type were found by means of the x-ray diffraction method. The parameters of Y and Mo were established in the crystal structure of the compound $YMoB_4$. (auth)

33857 INVESTIGATION OF SOLID-PHASE INTERACTION IN THE SYSTEMS COBALT–CARBIDES. Petrova, E. M.; Shcherban, N. I. (Inst. of Problems in Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 35-40(Jan 1972). (In Russian).

As a result of an investigation on the kinetics of solid-phase interaction in the system cobalt−carbide of transient metals of the IV−VI groups of the periodic system, it was established that growth of the layer of reaction products is subjected to the power time law and the reaction diffusion takes place in the system under consideration. A correlation was found between the parameters of the process of reaction diffusion and thermodynamic characteristics of carbides. The carbides studied included: TiC, ZrC, NbC, Cr_3C_2, Mo_2C, and WC. (auth)

33858 EFFECT OF SHOCK WAVES ON THE STRUCTURE OF REFRACTORY CARBIDES. Samsonov, G. V.; Alekseevskii, V. P.; Bozhko, S. A.; Yarosh, V. V. (Inst. of Problems in Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 93-100(Jan 1972). (In Russian).

The reduction of hot-pressed titanium, zirconium, and niobium carbide samples by shock waves resulted in the formation of a net of microcracks; side by side with the plastic deformation taking place in local volumes. Dislocation density determined by x-ray crystal analysis, as a result of explosive reduction, amounted to about 10^{10} cm^{-2} in hot-pressed samples and about 10^{11} cm^{-2} in powders. Plastic behavior of different carbide phases proved to be different and was determined by their electronic structure. (auth)

33859 INVESTIGATION OF SYSTEMS OF HIGH-REFRACTORY OXIDES. Lopato, L. M.; Shevchenko, A. V.; Kushchevskii, A. E. (Inst. of Problems in Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 88-92(Jan 1972). (In Russian).

An improved method is described for high-temperature differential thermal analysis (DTA) permitting the temperature of phase transitions of oxide materials to be measured up to 2400°C. On the basis of the above-mentioned method in combination with the data of petrographic and x-ray analyses the phase diagram of the Gd_2O_3−SrO system was investigated and plotted for the first time. (auth)

33860 INVESTIGATION OF THE FORMATION CONDITIONS AND SOME PROPERTIES OF ZIRCONIUM OXYCARBIDES. Kosolapova, T. Ya.; Fedorus, V. B.; Panasyuk, A. D.; Kozina, G. K. (Inst. of Problems in Material Management, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 60-4(Jan 1972). (In Russian).

Carbide and zirconium oxide reactions were studied to determine their solubility limits and boundaries of one-phase zirconium oxycarbide. By means of x-ray diffraction chemical and metallographic analyses it was established that the composition $ZrC_{0.7}O_{0.03}$ is limiting and maximum solubility of oxygen in zirconium carbide at 2000°C does not exceed 15 at. %. The existence of zirconium oxycarbide was substantiated by absorption spectra taken in the infrared region. Reactions of zirconium oxycarbide with liquid metals of the iron family showed that oxycarbides are more resistant in liquid metals than zirconium carbides and can be recommended as promising refractory materials. (auth)

33861 SOLID-STATE EQUILIBRIA IN THE SYSTEM MgO–Nb_2O_5–Cr_2O_3 WERE STUDIED AT 1400^0C. Rolando, Piero (Politecnico, Turin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 106: No. 2, 217-28(Mar-Apr 1972). (In Italian).

The phases are a solid solution of $(Mg,Nb)O_{2.417}$ type, another solid solution obtained from $CrNbO_4$ by partial introduction in the lattice of magnesium atoms and a monoclinic solid of the $(Nb, Mg, Cr)O_{2.478}$ type, which composition field is practically reduced to a point of composition $(Nb_{24.53}Mg_{0.12}Cr_{0.35})O_{62}$. The composition field of these phases was defined and lattice parameters calculated; bi- and triphases fields of the ternary diagram were identified. (auth)

33862 PHASES OF A FLUORITE STRUCTURE IN THE SYSTEMS Ca–U–O, AND Sr–U–O. Brisi, Cesare; Montorsi, Margherita; Acquarone, Giuseppina Burlando. Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 106: No. 2, 257-74(Mar-Apr 1972). (In Italian).

Cubic phases were studied which are obtained from UO_2 by replacement of uranium atoms with calcium or strontium. The calcium-saturated solid solution contains 33 at.% at 1100°C as well as at 1300°C. The strontium shows no solubility at 1100°, and a solubility of 20% at 1300°C. The atomic ratio of oxygen to uranium can also be higher than two. At 1100°C on the UO_2−$CaUO_4$ bond, a new phase was identified having a narrow homogeneity range around the formula $Ca_3U_5O_{16}$. (auth)

33863 PHASE EQUILIBRIA IN THE SYSTEM $UO_2-UO_3-NdO_{1,5}$ AND $NpO_{2+x}-NdO_{1,5}$. Keller, C.; Boroujerdi, A. (Kernforschungszentrum, Karlsruhe, Ger.). J. Inorg. Nucl. Chem.; 34: No. 4, 1187-93(Apr 1972). (In German).

In the $UO_2-UO_3-NdO_{1.5}$ part of the U–Nd–O ternary system, the following four single-phase regions were observed at 1250°C: β-U_3O_8 which did not show any solubility for A–$NdO_{1.5}$; a fluorite phase $(U, Nd)O_{2\pm x}$ which extended over the largest part of the system, and in which the valency of uranium varied from +4 to +6 with the limiting compositions $MeO_{1.6}$ and $MeO_{2.25}$; a rhombohedral phase with the limiting compositions $UO_3 \cdot 6NdO_{1.5}$ and $UO_2 \cdot 6NdO_{1.5}$, respectively, which showed no variation in the U : Nd-ratio; and A-$NdO_{1.5}$ which did not take up uranium oxides into solid solution. The single phase regions were separated by the corresponding two-phase-regions. The phase width of the fluorite phase increased with increasing temperature. At 1550°C and $p(O_2) = 1$ atm it reached from 13 to 81 mole % $NdO_{1.5}$ as may be seen in the phase diagram of the pseudobinary system $UO_{2+x}-NdO_{1.5}$. In the pseudobinary system $NpO_{2+x}-NdO_{1.5}$ ($p(O_2) = 1$ atm) four single-phase regions were observed between 1100 and 1550°C: two fluorite phases, a rhombohedral phase having $NpO_3 \cdot 6NdO_{1.5}$ as the oxygen-rich composition, and A-$NdO_{1.5}$. The thermal stability of the stoichiometric ternary oxides $(Np_{0.5}, Nd_{0.5})O_{2.00}$ with pentavalent Np and of $NpO_3 \cdot 6NdO_{1.5}$ with hexavalent Np was less than that of the isostructural uranium compounds. (auth)

33864 VAPORIZATION OF THE OXIDES OF RARE-EARTH METALS BY MEANS OF AN ELECTRON BEAM. Chernobrovkin, D. I.; Bakhtinov, V. V.; Sakharov, Yu. G. (Omsk Polytechnic Inst., USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 839-40(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 159-60(May-Jun 1971).

A procedure is considered for obtaining dielectric films based on refractory oxides of rare-earth metals by the method of electron bombardment in a vacuum. The block diagram of the electron-beam source and certain peculiarities of the vaporization of the oxides are presented. (auth)

33865 EFFECT OF SUBLIMATION AND MECHANICAL WEAR ON MASS LOSSES OF SOME REFRACTORIES INFLUENCED BY HIGH TEMPERATURE GAS STREAMS. Mayauskas, Yu. S.; Vishnyauskas, V. V. Liet. TSR Mokslu Akad. Darbai, Ser. B; 3: No. 66, 197-203(1971). (In Russian).

Results of studies are presented which indicate that the process of high temperature gas erosion can be considered as a complex of such processes as sublimation, mechanical (wear), and chemical interactions between gas stream and wall's substance. The influence of the first 2 factors on erosion is considered. Experimental data calculated on sublimation and experimental data— on erosion are compared. It is concluded that calculated sublimation rate is a criterion of mass loss in a high temperature erosion process. An equation for calculation of mass loss in the wear process based on the fatigue fracture theory is derived. (auth)

33866 ELECTRON SPECTRA AND PHYSICAL PROPERTIES OF DODECABORIDES. Goryachev, Yu. M.; Odintsov, V. V.; Paderno, Yu. B. (Inst. of Problems in Material Management, Kiev). Metallofizika; No. 37, 29-36(1971). (In Russian).

A number of physical characteristics of metal docecaborides were investigated, such as electrical resistance, thermal emf, microhardness, coefficient of thermal expansion, thermal conductivity, and the Hall constant. These data are tabulated for YB_{12}, TbB_{12}, DyB_{12}, HoB_{12}, ErB_{12}, TmB_{12}, LuB_{12}, YbB_{12}, and ZrB_{12}. A regularity of some of these properties was correlated with electron spectra. (K.S.W.)

33867 HYDROTHERMAL GROWTH AND ETCHING OF ZrO_2 CRYSTALS. Fujiki, Y.; Mitsuhashi, T.; Suzuki, Y. (National Inst. for Research in Inorganic Materials, Ibaraki, Japan). J. Amer. Ceram. Soc.; 55: No. 4, 223-4(Apr 1972).

A method is described for the hydrothermal growth and etching of ZrO_2 crystals using an HF solvent. The average size of thin platelets grown was 0.7 by 0.5 mm. The ZrO_2 crystals were always aggregated randomly as very thin platelets of the subhedral form. Individual crystals separated from an aggregation were characterized by well-developed {100} and {111} planes, although some crystals consisted of {100}, {110}, and {111} planes. No twinning was observed under polarized light on 100 planes. (P.C.H.)

33868 LIQUIDUS DETERMINATIONS IN THE 20 PERCENT SiO_2 PLANE OF THE QUATERNARY SYSTEM $CaO-Nb_2O_5-TiO_2-SiO_2$. Jongejan, A.; Wilkins, A. L. (Dept. of Energy, Mines, and Resources, Ottawa). J. Less-Common Metals; 27: No. 2, 101-8(May 1972).

Liquidus temperatures in the 20% SiO_2 plane of the $CaO-Nb_2O_5-TiO_2-SiO_2$ phase tetrahedron have been determined using the customary quench technique as well as hot-stage microscopy. The boundaries between the phase fields of $CaO \cdot TiO_2$, $CaO \cdot TiO_2 \cdot SiO_2$, TiO_2, SiO_2, $CaO \cdot Nb_2O_5$, $2\ CaO \cdot Nb_2O_5$, $10\ CaO \cdot Nb_2O_5 \cdot 6\ SiO_2$ (niocalite), and $2\ CaO \cdot SiO_2$ have been partly outlined. Pyrochlore could not be detected at this level, and the determinations in the $2\ CaO \cdot Nb_2O_5$ field were too few to yield information about the existence of $2\ CaO \cdot Nb_2O_5'$. The size of the 20% SiO_2 intersection with the niocalite field in the $CaO-Nb_2O_5-SiO_2$ system appeared to increase with the addition of TiO_2. (auth)

33869 CHARGE LOCALIZATION AT METAL–INSULATOR TRANSITIONS IN Ti_4O_7 AND V_4O_7. Marezio, M.; McWhan, D. B.; Dernier, P. D.; Remeika, J. P. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 28: No. 21, 1390-3(22 May 1972).

Single-crystal x-ray investigations revealed charge localization in the insulating phases of Ti_4O_7 and V_4O_7. Chains of M^{3+} and M^{4+} sites ran parallel to the pseudorutile c axis, whereas the metal valences were disordered in the metallic phases. The 3+ and some of the 4+ sites form metal–metal pair bonds, and the unpaired 4+ sites had one short metal–oxygen distance. (auth)

33870 HEATS OF IMMERSION IN THE ZIRCONIUM OXIDE–WATER SYSTEM. Holmes, H. F.; Fuller, E. L. Jr.; Gammage, R. B. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 76: No. 10, 1497-1502(11 May 1972).

Calorimetric measurements of the heat of immersion of zirconium oxide in water were made using samples outgassed at temperatures ranging from 25 to 500°C. Samples having a common chemical history and specific surface areas of 3.7 to 87.4 m^2/g (calcining temperatures of 600 to 1000°) were used. The magnitude of the heat of immersion (values ranging up to −1100 ergs/cm^2) clearly indicates that the initial interaction of water with an outgassed zirconium oxide surface is chemical in nature. A significant fraction (varying from 8 to 36%) of the heat of immersion was observed as a slow evolution of heat. This slow component could be separated into two concurrent first-order processes having half-lives of 4 to 30 min. The sample having the largest specific surface area exhibited a pronounced maximum in the heat of immersion as a function of the outgassing temperature. There is experimental evidence that the slow heat release and the maximum are phenomena related to porosity and an increase in hydrophobicity at the higher outgassing temperatures. Relating the results to the crystal modification present in the various samples strongly suggests that the metastable tetragonal form has a much lower surface energy than the stable monoclinic form. With the exception of the just-mentioned phenomenon the heat of immersion (on a unit area basis) decreased with decreasing specific surface area. (auth)

33871 THALLIUM TANTALATES OBTAINED BY THE SOLID-PHASE SINTERING OF Tl_2O_3 WITH Ta_2O_5. Plotkin, S. S.; Plyushchev, V. E. (Moscow Inst. of Fine Chemical Tech.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 83-7(Jan 1972). (In Russian).

X-ray and thermal analyses were used for the investigation of the solid-phase interaction between Tl_2O_3 and Ta_2O_5 in the temperature range 20 to 600°C. In the system $Tl_2O_3-Ta_2O_5$ the existence of thallium tantalates with molecular ratio $Tl_2O_3 : Ta_2O_5 = 3 : 2$ and $3 : 1$ was established. Thermal and chemical stability and dielectric properties of these compounds were studied. (auth)

33872 SINGLE CRYSTALS OF REFRACTORY COMPOUNDS. COMMUNICATION I. A REVIEW. Andrievskii, R. A.; Rymashevskii, G. A.; Sinel'nikova, V. S. Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 48-58(Mar 1972). (In Russian).

A generalized and systematic review is presented on the results of research on obtaining single crystals of refractory compounds. Practically all the carbides, except for SiC, were produced mainly under laboratory conditions. In the production of filamentous refractory single crystals, the precipitation from a gaseous phase plays a decisive role. To grow single crystals of large size with the controlled frequency and orientation the methods of melting according to Verneil and zone melting are the most suitable and universal. While obtaining single crystals by these methods the cermet technology is of great importance because it determines the quality of starting raw material and blanks. (65 references). (auth)

33873 INVESTIGATION OF CONDITIONS FOR OBTAINING HIGH-POROUS MATERIALS OF COMPLEX CARBIDES. Vitryanyuk, V. K.; Arbuzov, E. A. (Kiev Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 59-63(Mar 1972). (In Russian).

The conditions for obtaining high-porosity materials of complex carbides TiC–ZrC and TiC–NbC at combined reduction–carbidization of metal oxides with carbon in vacuum were studied. It was found that by this method articles with 58 to 64% porosity may be obtained from solid solutions of TiC–ZrC and with 70 to 78% porosity from TiC–NbC with a satisfactory chemical composition of alloys and sufficient isomeric property of pores. A greater compaction during sintering of articles made of complex carbides TiC–ZrC than those of TiC–NbC is explained by a less bond strength $Me^{I}-M^{II}$ in the former. (auth)

33874 EQUILIBRIUM BETWEEN OXYGEN AND MOLYBDENUM TRIOXIDE MELTS. Rahmel, A.; Schorr, Monika (Dechema-Institut, Frankfurt am Main). Z. Phys. Chem. (Frankfurt); 77: No. 1-6, 331-2(1972). (In German).

Melts of MoO_3 were brought to equilibrium at 850°C in N_2-O_2 mixtures with partial pressures of oxygen from 1 to 1×10^{-3} atm. Depending on partial oxygen pressure, equilibrium was reached after 8 to 24 hours. Following this time period, samples were analyzed for Mo^{5+} ions. The analytical results agreed with those of electrochemical measurements. The formula for the equilibrium was established. The equilibrium constant was approximately 1×10^{-3} atm$^{1/4}$. (H.B.G.)

33875 PHASE EQUILIBRIUM AND THERMODYNAMICS OF THE TERNARY SYSTEMS Fe–Mo–O AND Fe–W–O. Schmahl, Norbert G.; Dillenburg, Helmut (Univ. des Saarlandes, Saarbruecken, Ger.). Z. Phys. Chem. (Frankfurt); 77: No. 1-6, 113-26(1972). (In German).

Through isothermal reduction at 900°C for CO/CO_2 gas mixtures, equilibrium measurements were performed on the ternary systems Fe–Mo–O and Fe–W–O. Knowledge concerning the isothermal phase triangle Fe–Mo–O was extended. The compound $Fe_4Mo_6O_{16}$ accepted MoO_2 in solid solution. Formation of the intermetallic phase Fe_3Mo_2 was not detectable at 900°C. The existence of FeMoO, Fe_3Mo_3O, $FeMoO_x$, and $FeMoO_3$ under the given conditions was also questionable. Activities in the uninterrupted series of mixed crystals from FeO_4 to $FeMoO_4$ were calculated. In the binary system W–O and at 900°C, only WO_3, $WO_{2.75}$, and WO_2 existed. Additional properties of the ternary system were established. (H.B.G.)

33876 PROCESS FOR PRODUCING FULL DENSITY URANIA PARTICLES. St. Pierre, Philippe Douglas Sherwood (to General Electric Co.). British Patent 1,271,924. 26 Apr 1972. Priority date 29 Apr 1969, United States.

A process for producing uranium dioxide particles having substantially 100 percent of the theoretical density is described. A polycrystalline sintered urania body having about 95 percent of the theoretical density is heated to a temperature in the range of 1900 to 2300°C under a dry hydrogen atmosphere for a period of time ranging from one to four hours. The body is then cooled in a dry substantially unreactive environment to disintegrate it into monocrystals. The polycrystalline sintered urania body disintegrates at the grain boundaries to form a fine powder consisting of individual grains or crystallites which have been found to have substantially full theoretical density. (J.R.D.)

33877 THERMAL DECOMPOSITION OF URANIUM OXYCARBIDES IN A VACUUM. Vlasov, V. G.; Larin, A. A.; Sedykh, N. Ya. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 119-21(1971). (In Russian).

Experimental data on the thermal stability of the compounds $UC_{0.93}O_{0.07}$, $UC_{0.81}O_{0.19}$, $UC_{0.72}O_{0.28}$, and $UC_{0.68}O_{0.32}$ were obtained at the temperatures 1,400, 1,500, 1,600, and 1,700°C. The first two oxycarbides listed remained practically undecomposed at these temperatures. The formation of U and CO was noted in the remaining cases; dissociation was more appreciable at higher temperatures and in those samples with higher oxygen content. (K.S.W.)

33878 NEUTRONOGRAPHIC INVESTIGATION OF Nb_4N_3. Chervyakov, A. Yu.; Somenkov, V. A.; Umanskii, Ya. S.; Shil'shtein, S. Sh.; Yanchur, V. P. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 140-4(1971). (In Russian).

Confirmation of the structure of Nb_4N_3 and its possible alteration at elevated temperatures was studied with the aid of neutron diffraction. Samples of Nb_4N_3 were prepared by heating Nb foil in a N_2 atmosphere at 1,900°C for 6 h, and subsequent annealing at various temperatures up to 2,050°C. A comparison of experimental reflection intensities with those calculated from the Terao model was made. (K.S.W.)

33879 STRUCTURE AND TEMPERATURE OF THE BRITTLE–MALLEABLE TRANSITION OF SOME ALLOYS IN THE Cr–Ti–V–B SYSTEM. Zolotorevskii, V. S.; Indenbaum, S. V.; Karsonov, G. V.; Khazanova, T. P. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 133-5(1971). (In Russian).

The effects of Ti concentration on the structure and temperature of brittle-malleable transitions of hot-pressed bars of alloys of the system Cr–Ti–V–B were studied. The concentrations of the added metals were: Ti-0.25 to 1.5%; V-1.5%; and B-0.05%. Where traces of N_2 were present in the protective atmosphere of argon, a significant amount of surface nitride, TiN, was formed. (K.S.W.)

33880 SOLUBILITY OF CARBON IN NIOBIUM. Druzhinin, I. I.; Zakharov, A. M.; Novikov, I. I. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 136-9(1971). (In Russian).

Samples of Nb–NbC alloy which contained up to 1.84% C by weight were used to study the solubility of carbon in niobium. The solubility of carbon was about 1.4% at 2,100 to 2,000°C, and 0.25% at 1,200°C. These values were much higher than those obtained by others. The discrepancy is discussed. (K.S.W.)

33881 INVESTIGATION OF LATERAL PRESSURE DISTRIBUTION DURING PRESSING TUNGSTEN CARBIDE MIXTURES WITH COBALT. Meerson, G. A.; Ivensen, V. A.; Sapronov, E. I; Vissarionov, V. B. Porosh. Met., Akad. Nauk Ukr. SSR; No. 2, 15-18(Feb 1972). (In Russian).

Data are presented on lateral pressure distribution in briquettes composed of tungsten carbide mixed with cobalt during pressing. Lateral pressure was measured by deformation of rings composing the body of the press-mold. It is shown that cobalt, the plasticity of which is higher than that of tungsten carbide, increases the powder friction against the press-mold walls and simplifies the sliding of carbide particles with respect to each other. Interaction of these factors determines the character of pressure transfer through the mass of powder and distribution of powder pressure to the walls of the press-mold. (auth)

33882 SYSTEMS METAL–BORON–NITROGEN (REVIEW). Medvedeva, O. A. Porosh. Met., Akad. Nauk Ukr. SSR; No. 2, 38-45(Feb 1972). (In Russian).

Literature data are reviewed on the Me–B–N systems; the results obtained in the present experiments being added. The difference in equilibrium states of these systems is discussed as related to metal position in the periodic system, change in the type of chemical bond, and crystalline and electronic structure of boride and nitride atoms forming the system. (auth)

33883 INVESTIGATION OF THE COBALT MELT REDISTRIBUTION PROCESS IN CERMET HARD ALLOYS WC–Co. Lisovskii, A. F.; Babich, M. M. (Inst. of Superhard Materials, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 2, 53-8(Feb 1972). (In Russian).

It was established that the cobalt content and tungsten carbide particle size produce the main effect on the process of liquid phase redistribution in hard alloys. A deduced condition for liquid phase equilibrium permits the direction of liquid migration in alloys to be determined. (auth)

33884 SOLID PHASE INTERACTION BETWEEN Ta_2O_5 AND Ga_2O_3 OR In_2O_3. Plotkin, S. S.; Plyushchev, V. E. (Moscow Inst. of Fine Chemical Tech.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 2, 69-73(Feb 1972). (In Russian).

Solid phase interaction between Ta_2O_5 and Ga_2O_3 or In_2O_3 was studied by means of x-ray and thermal analyses. It was found that the hydroxide coprecipitation essentially decreased the equilibrium time in the solid mixture. Orthorhombic $GaTaO_4$, monoclinic wolframite structure $InTaO_4$ and unstable phases in the concentration limit 7.5 to 12.5 mol % M_2O_3 (M = Ga or In) were determined in the $M_2O_3-Ta_2O_5$ systems. $GaTaO_4$ and $InTaO_4$ melt congruently at 1695 and 1900°C respectively. Their resistivity in the air has an order of 10^{10} ohm/cm at room temperature. Both compounds demonstrate a high chemical and thermal resistance. (auth)

33885 METALLOGRAPHIC INVESTIGATION OF THE LAYER BUILT-UP BY NIOBIUM AND MOLYBDENUM CARBIDES. Krasnov, A. N.; Kravets, Zh. A. Porosh. Met., Akad. Nauk Ukr. SSR; No. 2, 104-7(Feb 1972). (In Russian).

Results of research showed a possibility of depositing pure carbides on steel. The obtained layer possesses high hardness In the process of deposition by open arc, the starting composition of carbide changes due to partial carbon combustion. (auth)

33886 INVESTIGATION OF THE V_3N PHASE IN THE VANADIUM–NITROGEN SYSTEM. Potter, Donald; Geils, Ronald (Union Coll., Schenectady, N. Y.). Scr. Met.; 6: No. 5, 395-8 (May 1972).

In the course of study of the vanadium nitrogen system, alloys containing up to 9.0 at. % nitrogen were examined in the electron microscope in the quenched and aged conditions. One eighth inch by 0.010″ ribbons of 99.90% pure vanadium (100 wt ppM total interstitial solute) were first Joule heated to 1340°C in a pressure of 10^{-8} torr for one hour and then alloyed by introducing measured quantities of nitrogen into the system containing the specimen. Monitoring of the pressure as the reaction proceeded showed that the sample absorbed essentially all the nitrogen. The ribbons were then rapidly cooled to room temperature by simultaneously introducing helium gas at 1 atm pressure and shutting off the heating current. Samples $\frac{1}{8}″ \times \frac{1}{8}″ \times 0.010″$ were then cut from these ribbons and subsequently aged at 640°C for 30 hours in a vacuum of $<10^{-8}$ torr and again helium quenched. Previous experience shows this treatment causes no nitrogen loss from the sample. The samples were then prepared for transmission electron microscope observation by jet machining and uniform field polishing with 20% H_2SO_4 in methanol. The aged samples were observed to consist of two phases of which one was the body centered cubic, interstitial solution of nitrogen in vanadium. The other phase, which was in the minority and amounted to as much as 10 vol % of the material, was heavily twinned. This phase was found to be the V_3N phase investigated with x-ray techniques by Hahn. This was verified by producing several selected area electron diffraction patterns of different orientations including $\{100\}$, $\{110\}$, $\{111\}$, $\{112\}$ and $\{113\}$ referenced to the body centered cubic α phase. These patterns showed the presence of extra spots when the precipitate or second phase was included in the aperture. These spots were indexable on the basis of an hexagonal close packed metal atom lattice with a c/a ratio of 1.62 ± 0.01 which is in close agreement with that of 1.602 given by Hahn for V_3N. From several patterns the ''a'' parameter of the precipitate was found to be 2.80 Å* which also compares favorably with the value of 2.831 Å found by Hahn. (auth)

33887 HELIUM MIGRATION IN GLASS-FORMING OXIDES. Shelby, J. E. (Sandia Labs., Livermore, Calif.). J. Appl. Phys.; 43: No. 7, 3068-72(Jul 1972).

Permeation, diffusion, and solubility of helium in vitreous B_2O_3, SiO_2, and GeO_2 were measured. The permeability and diffusivity decrease in the order $B_2O_3 > SiO_2 > GeO_3$, whereas the solubility decreases in the order $SiO_2 > B_2O_3 > GeO_2$. Differences in the activation energy for diffusion between vitreous SiO_2 and GeO_2 are due to the greater strain energy necessary to distort the GeO_2 structure sufficiently to allow passage of a helium atom from one interstice to another. Changes in the frequency factor for diffusion appear to be primarily related to the activation entropy. The solubility appears to be a function of the distribution of interstice sizes, but cannot be predicted by present techniques. (auth)

33888 FURTHER OBSERVATIONS ON FRACTURE ENERGIES IN VC MONOCRYSTALS. Govila, R. K. (Oakland Univ., Rochester, Mich.). Scr. Met.; 6: No. 5, 353-5(May 1972).

Fracture energy of VC monocrystals was determined using a recently established elastic modulus value of $E_{100} = 4.77 \times 10^{12}$ dynes/cm^2. Data on cleavage surface energies as a function of composition are given along with data on variation of fracture energy as function of composition and temperature. (J.R.D.)

Metals and Alloys

Refer also to abstracts 33185 and 33845.

33889 (JPRS-55807) NEW INDUSTRIAL MATERIALS. Bel'skii, E. I.; (and others). Translated from pp 3-55; 114-46; 249-65; 269-71 of Novye Materialy v Tekhnike, Belarus' Publishing House, Minsk, 1971. 93p. NTIS.

Topics covered include: high-alloy steels and other alloys, titanium and its alloys, rare and refractory metals, zirconium and its alloys, and protective coatings. (M.C.G.)

33890 KONSTRUKTSIONNYE MATERIALY YADERNYKH REAKTOROV. CHAST' I. YADERNYE I TEPLOFIZICHESKIE SVOISTVA, OSNOVY KORROZII I ZHAROPROCHNOSTI. (Materials of Construction for Nuclear Reactors. Part I. Nuclear and Thermophysical Properties, Elements of Corrosion and Heat Stability). Beskorovainyi, N. M.; Belomyttsev, Yu. S.; Abramovich, M. D.; Ivanov, V. K.; Shulepov, V. I. Moscow; Atomizdat (1972). 240p.

Basic requirements for the materials of construction of a nuclear reactor are reviewed. Material characteristics for fuel element cladding, the reactor itself, and steam generator are summarized. Nuclear and thermophysical properties of metals and alloys, their cross sections, heat conductivity and capacity, and thermal expansion are highly pertinent to the subject. Three chapters are concerned with corrosion and associated phenomena: dissolution of solids in liquids, absorption of gases by metals, reaction with oxygen, electrode processes, and corrosion in gaseous, liquid and liquid metal coolants. The effects of the crystalline structure of metals, the presence of defects, influence of impurities, and grain boundaries are described. The heat stability and the mechanisms of creep at low and high temperatures are considered. (21 references) (K.S.W.)

Corrosion and Erosion

Refer also to abstracts 33123, 33885, 35199, and 35345.

33891 (DP-1289) CORROSION OF MAGNESIUM ALLOYS AND CERAMICS. Ondrejcin, R. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1972. Contract AT(07-2)-1. 28p. Dep. NTIS.

The resistance of 42 experimental magnesium alloys to corrosion by hot, refreshed deionized water was determined to select candidate materials for nuclear reactor moderator displacers. The most promising of these alloys were subsequently tested in 80 to 115°C water controlled at pH 5 and flowing 5 ft/sec. Four of these alloys, Mg-5Al-2Sn, Mg-1Si, Mg-5Al-0.5Ce, and Mg-3Al-0.2Ca, are more corrosion resistant than the best commercial alloy tested, AZ31B (3Al-1Zn-0.2Mn); these four alloys also meet the requirement of high scatter and low neutron absorption cross sections. Corrosion rates for all alloys without cladding were too high for reactor use. Limited studies of potential ceramic materials showed that $MgAl_2O_4$ should be suitable, from a corrosion standpoint, as an alternative material if aluminum-clad magnesium alloys were found unsuitable for other reasons. (auth)

33892 (DPST-61-401) GALVANIC CORROSION OF ALUMINUM-ZIRCONIUM, ALUMINUM-STAINLESS STEEL, AND STAINLESS STEEL-ZIRCONIUM COUPLES. A Literature Search. Smith, L. L. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 3 Aug 1961. Contract AT(07-2)-1. 3p. Dep. NTIS.

Declassified 28 Oct 1971.

A literature search was made for information on the galvanic corrosion of Al-stainless steel, Al-Zr (or Zircaloy) and stainless steel-Zr (or Zircaloy) couples in H_2O. Results of an investigation of Nuclear Science Abstracts vol 1 to 15 (1948 to 6/61) and Abstracts of Classified Reports, vol 1 to 17 (1947 to 5/16) are presented. (J.R.D.)

33893 (INIS-mf-213) CORROSION PROBLEMS DUE TO TWO-PHASE FLOW. Tillequin, J. F. (Societe Babcock-Atlantique, Paris (France)). 25 Mar 1971. 11p. (In French). (CONF-710317-9). INIS.

From sixteenth nuclear congress; Rome, Italy (25 Mar 1971).

Two-phase flow poses two kinds of problems: some, due to physical phenomena that can generally be resolved in good time, and the other, corrosion, that is often manifested after a relatively long time. This is why it has not always been known how to avoid them in conventional boilers and in the heat exchangers of graphite-gas, natural uranium nuclear power plants. The Corine loop makes it possible to study corrosion by water-vapor emulsion of tubes of slightly different composition subjected to asymmetric heat fluxes which occur in the combustion chambers of boilers. Finally, Corine could be used for a study of corrosion under thermal flux in nuclear heat exchangers. (tr-auth)

33894 (N-70-43082) FUNDAMENTALS OF THE OXIDATION PROTECTION OF TANTALUM. Final Report. Kolodney, M.; Graff, R. A. (City Coll., New York). 1 Oct 1970. 164p. (NASA-CR-110894; CC-70-243-10). NTIS.

A fundamental study of the protection of tantalum by silicides has been performed. Thermodynamic properties of all tantalum silicides have been measured by an emf method using solid electrolytes. Considerable improvement over older data has been obtained. Measurements have also been made of the degradation of silicide coatings by diffusion of silicon into the tantalum substrate. These measurements permit estimates of time and temperature effects on lifetimes of coatings. Barriers to diffusion have been investigated, but no good ones found. Lastly, the oxidation process has been studied in terms of a silicide ($TiSi^2$) that forms a stable metal oxide. It has been shown that oxidation protection may be retained if the metal oxide can be embodied in the surface silica glass of the coating. (STAR)

33895 (PNC-N-831-70-2, pp 65-9) HYDRIDING OF ZIRCONIUM ALLOYS. Hirai, Ken-ichi; Aoki, Toshimasa; Ui, Masayasu; Yokosawa, Naoki (Power Reactor and Nuclear Fuel Development Corp., Tokai (Japan)). Dec 1970. (CONF-700345-8).

From Annual meeting of the Atomic Energy Society of Japan; Hiratsuka, Japan (27 Mar 1970).

Some methods to introduce known amounts of hydrogen into zirconium alloys were tested. Methods included the corrosion method, the electrolytic method, and the gas-phase hydriding method. The first was performed in sealed stainless steel autoclaves containing about 1 l solution at various temperatures and LiOH concentrations. At the end of corrosion period the autoclaves were cooled to room temperature, and after weighing and external inspection, hydrogen analysis and metallographic tests were conducted. Then weight gain, hydrogen content, and hydrogen pickup of specimens were calculated. In the second method, specimens used as cathodes were expected to absorb hydrogen generated by electrolysis. The third method was developed for hydriding Zr−2.5% Nb alloy. The hydrogen absorbed was calculated from pressure drop and/or weight gain. The corrosion method was sufficiently adaptable to thick Zr specimens, and solutions containing 17 g/l LiOH at 340°C or 6 g/l LiOH at 360°C was found to be adequate. But hydriding of Zr−2.5% Nb alloy using LiOH was slower than that of Zircaloy because of surface corrosion of Zr−2.5% Nb. Nickel plating of Zr−2.5% Nb alloy was not adequate. Since the electrolytic method did not give effective results, further work should be done. The gas-phase method was found applicable to thick Zr−2.5% Nb specimens. Hydriding by this method was faster than that by LiOH corrosion method. Moreover, by this method, the content of absorbed hydrogen can be exactly predicted. (Japan)

33896 (SC-RR−710426) STRESS CORROSION CRACKING BEHAVIOR OF U−$4\frac{1}{2}$ WT PERCENT Nb IN LABORATORY AIR. Magnani, N. J.; Boultinghouse, K. D.; Miglionico, C. J. (Sandia Labs., Albuquerque, N. Mex.). Mar 1972. 20p. Dep. NTIS.

The stress corrosion cracking behavior of U−$4\frac{1}{2}$ wt % Nb was determined by dry (~10% RH) air using side-grooved tapered double-cantilevered-beam specimens. Crack propagation was monitored using crack opening displacement gages and acoustic emission detection techniques. The threshold stress intensity for stress corrosion cracking was determined to be ~20 ksi$\sqrt{\text{in.}}$ (22 MN/$m^{3/2}$) and the plane strain fracture toughness ~50 ksi$\sqrt{\text{in.}}$ (55 MN/$m^{3/2}$). (auth)

33897 Hf BASED ALLOY. Armand, Marcel; Dabosi, Francis; Pieraggi, Bernard (to Ugine–Kuhlmann). French Patent 2,074,709. 8 Oct 1971. Filed 20 Jan 1970. (In French).

An oxidation resistant Hf alloy was developed. It may be used for the control rods of pressurized water reactors. It contains between 0.1 and 15 at. % Cu (preferably 1 to 6 at. %). In addition it possesses up to 5% by weight of Zr, less than 0.6% by weight of O_2, N_2, C, Si, P, and B, up to 0.2% by weight of Al, up to 0.2% by weight of Sn, and up to a total of 2% of other impurities. (France)

33898 FLASH-METHOD STUDY OF KINETICS OF THE OXYGEN–NIOBIUM INTERACTION. Ageev, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2816-20(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3353-8(Nov 1971).

The thermal-flash method has been used to study the kinetics of the oxygen−niobium interaction in a pulsed time-of-flight mass spectrometer. The oxygen is desorbed during the flash as the oxide NbO. The dependences of the sticking coefficient of oxygen on Nb on the extent of oxygen absorption and on the temperature are qualitatively similar to the analogous dependences for tantalum. At temperatures $T < 750°K$ the sticking probability S for coverages $\theta < 0.6$ does not depend on the coverage or temperature and is equal to ~0.09. For $T > 750°K$ the initial sticking probability increases with increasing T and is equal to ~0.17 at $T \simeq 1700°K$. For $\theta > 1$ the sticking probability does not depend on θ and increases with increasing T. Oxygen desorption from the Nb is shown to obey an Arrhenius equation, in which the activation energy F is governed by the desorption and dissolution activation energy. The experimental F value is 6 ± 0.3 eV. (auth)

33899 STUDY OF FRETTING-CORROSION IN ZIRCONIUM ALLOYS. Blanchet, J.; (CEA–CEN, Fontenay-aux-Roses, France); Coriou, H.; Grall, L.; (and others). Corros.-Trait., Prot., Finition; 20: No. 1, 19-29(Jan-Feb 1972). (In French).

The fretting-corrosion of Zr alloys vibrating in water and in contact with a stainless steel support was studied. The original device used allowed well defined conditions to be maintained for the water temperature, vibration amplitude, vibration frequency and sample contact pressure. The various tests made on Zircaloy-2 revealed: at 300°C, marked wear with hydridation of the metal occurs. The effect of a preoxidation treatment was investigated; at 80°C, a negligible decrease in thickness and a significant superficial hydridation of the surface subjected to friction takes place. Less severe wear was observed for the Zr−Nb(2.5%) alloy in water at 300°C. (France)

33900 INVESTIGATION OF THE FAILURE OF A TUNGSTEN TURBULENCE PLATE. Kampmann, Christel; Kirner, Kuno (Technisches Zentrum Forschung, Stuttgart). Prakt. Metallog.; 9: No. 3, 139-46(Mar 1972). (In German and English).

Results of combustion experiments are presented which indicate that the plate contained localized Fe, Cr, and Ni impurities. It is concluded that tungsten and molybdenum turbulence plates exposed to extremely high temperatures should not be contaminated by low melting metals such as iron, nickel, or chromium which may give rise to melting and to blisters, i.e., to a premature failure of a whole power unit. The same conclusions are applicable for nozzles and other high temperature rocket components. (J.R.D.)

33901 OXIDATION BEHAVIOR OF A COMPLEX DISILICIDE/TANTALUM–10 TUNGSTEN ALLOY SYSTEM AT TEMPERATURES OF 1700^0F (927^0C) TO 2700^0F (1482^0C). Levy, M.; Falco, J. J. (Army Materials and Mechanics Research Center, Watertown, Mass.). J. Less-Common Metals; 27: No. 2, 143-62(May 1972).

The oxidation behavior of a complex disilicide coating/90 Ta−10 W alloy system was studied utilizing thermogravimetric, x-ray diffraction, and electron microprobe analyses. The coating afforded the alloy substrate complete protection against static oxidation for at least 200 h at temperatures between 1700 and 2700°F (927 and 1482°C). The excellent oxidation resistance of the coating system was due to the formation of a protective layer which consists mainly of SiO_2 presumably with some Ti, V, and W in solution and a second dispersed phase of TiO_2. While this protective layer is glassy at and above 2100°F (1149°C) the reaction products became increasingly crystalline with decreasing temperature between 1700 and 2000°F (927 and 1093°C). (auth)

33902 OXYGEN REACTIONS ON PLATINUM AND RHENIUM. Cassuto, A.; Peutenero, A.; Weber, B. (CNRS, Nancy). J. Vac. Sci. Technol.; 9: No. 2, 788(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

A summary is presented of results and conclusions on the reactions of O_2 with recrystallized Pt and Re. Atomic O is the main product when samples are heated in O_2 below 10^{-4} torr at the highest temperatures. ReO_3 is formed, and the equation for its production rate is also obeyed by the other reactions. (12 references) (D.L.C.)

33903 RETARDATION OF PLUTONIUM OXIDATION BY A PuO SURFACE FILM. Larson, D. T.; Cash, D. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Vac. Sci. Technol.; 9: No. 2, 800-3(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

An anomalous rate minimum exists at about 400°C for the oxidation of plutonium, i.e., there is a decrease in the oxidation rate as the temperature is increased toward the rate minimum. In situ x-ray diffraction studies have shown that in the temperature region of the rate minimum, there is an increased rate in the formation of PuO. The influence of a PuO surface film on the oxidation of plutonium was investigated with an ellipsometer to determine if a PuO film affects the oxidation rate. Measurements showed that the PuO surface film does retard oxidation at 80°C. It is further postulated that the anomalous rate minimum for plutonium oxidation near 400°C results from the increased rate of formation of the protective PuO surface film. (auth)

33904 SHORT-TIME OXIDATION OF ZIRCONIUM. Srivastava, L. P. (Regional Engineering Coll., Srinagar, India); Archbold, T. F. Scr. Met.; 6: No. 5, 357-60(May 1972).

Results are presented of experiments in which Zr was exposed to O for periods of 3 min at 440 to 850°C. Results are discussed. It is noted that the results conform to the parabolic/linear equation $\Delta W^2 + K_1(\Delta W) = K_2 t$ where ΔW is the weight gain. (J.R.D.)

Preparation and Fabrication

Refer also to abstracts 33213, 33306, 33550, and 34786.

33905 (GAT-T−1849) MICROPROBE STUDIES OF DISSIMILAR METAL WELD PROBLEMS. Boyd, D. E. (Goodyear Atomic Corp., Piketon, Ohio). 18 Apr 1972. Contract AT(33-2)-1. 35p. (CONF-720418−1). Dep. NTIS.

From High alloys committee of the welding research council conference; New York, NY. (18 Apr 1972).

Results of electron microprobe studies being conducted using dissimilar metallic materials are reviewed. Data and information are included on Monel-carbon steel welds, nickel−carbon steel welds, and aluminum−nickel welds. (J.R.D.)

33906 (HW-64856) BILLET DESIGN FOR NPR OUTER TUBE FUEL ELEMENTS. Nickolaus, J. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 20 Apr 1960. Contract AT(45-1)-1350. 5p. Dep. NTIS. Declassified 2 Nov 1971.

Billet dimensions and extrusion conditions are given for the fabrication of NPR U—Zircaloy-clad fuel tubes. (D.E.B)

33907 PANTOGRAPHIC METHOD OF PREPARING STYROFOAM MOLDS FOR SELECTIVE SHIELDING IN LARGE-FIELD RADIATION THERAPY. Hendee, William R.; Lindsey, Lyle F. (Univ. of Colorado Medical Center, Denver). Radiology; 102: No. 2, 439-40(Feb 1972).

The construction and use of a pantograph for the preparation of Styrofoam molds employed in large-field radiation therapy are described. This technique is feasible with any desired combination of source–skin, source–shield, and shield–skin distances. (auth)

33908 PROCESS FOR OBTAINING PREFERRED ORIENTATION IN ZIRCONIUM AND ITS ALLOYS. (to Westinghouse Electric Corp.). British Patent 1,270,563. 12 Apr 1972. Priority date 27 Sep 1968, United States.

The allotropic transformation from beta-phase to alpha-phase is controlled in order to induce a preferential orientation within the alpha phase texture wherein the basal pole of the grains is oriented substantially perpendicularly to the surface of the zirconium or zirconium-base alloy material. The process utilizes the variation of surface energy of a metallic crystal with respect to its orientation. Grains occupying surface positions in the polycrystalline aggregate have a surface free energy which depends upon their orientation with respect to the surface. This anisotropy of surface energy can be greatly enhanced by the action of surface active agents. Interaction of the surface active agent with the metal at the gas-metal interface promotes the preferred growth of (110) beta secondary grains and the subsequent preferred nucleation of alpha grains oriented with the basal pole normal to the surface during the allotropic transformation. (J.R.D.)

33909 FUSION WELDING OF TITANIUM–TUNGSTEN AND TITANIUM–GRAPHITE COMPOSITES. Kennedy, James R. (Grumman Aerospace Corp., Bethpage, N. Y.). Weld. J. (N. Y.); 51: No. 5, 250s-9s(May 1972).

Fusion welding experiments were conducted on two titanium matrix composite systems: titanium–tungsten wire and titanium–graphite filament. The objective was to determine the weldability of model composites and observe the influence of weld thermal energy on fiber-matrix reactions. Results of mechanized and manual gas tungsten-arc (GTA) welding tests indicated that well diffusion-bonded composites generally presented no unusual problems during fusion. The extent of fiber-matrix reactions in both systems was directly proportional to the welding energy input. As energy input increased, tungsten wire dissolution became greater and titanium carbide formation around the graphite filaments grew thicker. Welding energy input thus becomes a significant factor in controlling the nature of fiber-matrix reaction products. Tensile properties of titanium–tungsten composites, both as-diffusion bonded and as-welded, were compared. (auth)

33910 OPEN ALUMINOTHERMIC REDUCTION OF VANADIUM OXIDES. Mukherjee, T. K.; Gupta, C. K. (Bhabha Atomic Research Centre, Trombay, India). J. Less-Common Metals; 27: No. 2, 251-4(May 1972).

Studies were made on the preparation of pure V by open aluminothermic reduction of both oxides of V, V_2O_5 and V_2O_3. The results showed that it was possible to obtain well separated V by this method. The products from the reduction of V_2O_3 were adequately refined by a combination of pyrovacuum treatment and electron-beam melting. The processing of the V_2O_5 reduction product to V of comparable purity to that from V_2O_3 reduction was accomplished by using a molten salt electrorefining technique. (P.C.H.)

33911 DISPERSE HARDENING OF REFRACTORY METALS (REVIEW). Samsonov, G. V.; Alfintseva, R. A. Porosh. Met., Akad. Nauk Ukr. SSR; No. 2, 19-32(Feb 1972). (In Russian).

Dispersion hardening of niobium, chromium, molybdenum, and tungsten was studied. Disperse hardening of refractory metals with oxides was studied most completely. ZrO_2, ThO_2, and HfO_2 should be considered the best hardening additives for niobium, molybdenum, and tungsten and MoO and Al_2O_3 for chromium. The research concerning niobium, chromium, and molybdenum hardening with carbides is considered. The data are presented on the solid phase interaction of refractory compounds with refractory metals. Papers are reviewed on the effect of dispersed particles on molybdenum grain growth. Literature data are reviewed on main theoretical preconditions of dispersed particle stability in a metal matrix. (auth)

33912 VACUUM HEAT TREATMENTS IN THE C.E.R.N. Tech. Mod.; 63: No. 12, 463-4(Dec 1971). (In French).

CERN possesses two large furnaces (vacuum limit in the 10^{-5} to 10^{-6} torr range). High-temperature brazing was used in the following operations: construction of long Cu stacks, manufacture of 500-kg Cu blocks and stainless steel tubes (pressurized water condenser), realization of ceramic-metal joints, and in the joining of different metals. Various in-vacuo metallurgical treatments were affected (classical treatments and treatment of magnetic alloys). (France)

Properties, Structure, and Phase Studies

Refer also to abstracts 33299, 33305, 33835, 33879, 33880, 34788, 35301, 35316–35318, 35324–35326, 35331, 35332, 35336, 35340, 35341, 35343, 35348, 35355, 35427, and 35628.

33913 (AD-864043) INVESTIGATIONS OF TRANSITION METAL–RARE EARTH ALLOYS. PREPARATION, STRUCTURES, MAGNETIC, AND PERMANENT MAGNET PROPERTIES OF RARE EARTH–IRON AND COBALT INTERMETALLIC COMPOUNDS. Final Report. Lihl, Franz (Technische Hochschule, Vienna (Austria). Institut fuer Angewandte Physik). Oct 1969. Contract F61052-68-C-0016. 82p. (AFML-TR-69-245). NTIS.

The phase diagrams of the binary systems samarium–cobalt and gadolinium–cobalt have been established. The phases present have been checked by x-ray diffraction and x-ray fluorescence methods. The ternary system yttrium–iron–cobalt has been investigated in three essential concentration regions corresponding to the compositions Y(Fe,Co)2, Y(Fe,Co)5, and Y2(Fe,Co)17. Only in the case of Y2(Fe,Co)17 was complete solid solubility found, the other series showed only limited ranges of solid solubility. By the amalgam process the preparation of ReCo5 and Re(Co,Cu)5 alloys has been studied. The results have been compared with alloys prepared by high frequency melting. Quenching alloys of the composition Re(Co,Cu)5 showed complete solid solubility. By static and dynamic magnetic measurements the permanent magnetic properties of ReCo5 alloys, prepared by high frequency melting and by the amalgam process, have been measured. The influence of different milling methods and of different chemical treatments on the magnetic properties has been determined. Alloys prepared by the amalgam process were found to be superior to other alloys respective of their permanent magnetic properties. (NTIS)

33914 (BMBW-FBK-71-17, pp 14.1-14) PROTACTINIUM METAL AND ALLOYS. Cunningham, B. B. (California Univ., Berkeley). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

Information on methods of preparing Pa metal, physical and chemical properties, and alloys is discussed. Data on properties are tabulated. (P.C.H.)

33915 (BMBW-FBK-71-17, pp 16.1-13) PREPARATION OF Th–Pa ALLOYS AND DETERMINATION OF THE SOLUBILITY OF Pa IN Th. Lorenz, R. (Technische Universitaet, Brunswick (West Germany)); Scherff, H. L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The Van Arkel method was used for the preparation of Th–Pa alloys. The alloy preparation proceeds through the following steps: carbothermic reduction of the mixed oxides to the mixed carbides; preparation of the mixed iodides by reaction of the carbides with elementary iodine; and thermal decomposition of the iodide vapor at a heated wire. X-ray analysis of the specimens was carried out in order to determine the limit of solubility of protactinium in the α-thorium phase. The results showed that the solubility of Pa in α-Th can be determined to 6.7 ± 0.3% at 1300 ± 30°C and to 4.5 ± 0.5% at room temperature, respectively. The results indicate that in the range of technical interest with respect to the utilization of metallic Th in reactor fuel elements (3% Pa) complete solubility of the neutron generated ^{233}Pa in the thorium matrix would occur. Within the range of solubility the alloys were perfectly homogeneous in radial as well as in axial directions. (P.C.H.)

33916 (COO-1198-831) DISPLACIVE TRANSFORMATIONS IN NEAR-EQUIATOMIC NIOBIUM–RUTHENIUM ALLOYS. I. MORPHOLOGY AND CRYSTALLOGRAPHY. Das, Bijoy K.; Lieberman, David S. (Illinois Univ., Urbana). [1972]. Contract AT(11-1)-1198. 34p. Dep. NTIS.

Displacive phase transformations in near-equiatomic Nb–Ru alloys have been studied using electrical resistivity measurements, optical metallography, and x-ray diffraction. Alloys containing between 41 and 45 at. % Ru undergo a CsCl (β) to (β') transformation on cooling from 1500°C to room temperature. Alloys containing more than 46 at. % Ru exhibit a two step CsCl (β) to tetragonal (β') to orthorhombic (β'') transformation on cooling to room temperature. Although the product of each successive transformation consists of stacks of twins (in $\beta' \rightarrow \beta''$, twins within twins), the transformations do not proceed by the advance of sharp planar interfaces as in many of the first order martensitic transformations resulting in morphologically similar products. Rather, the interphase region consists of a small volume of the crystal over which the parent phase is gradually distorted into the product phase. (auth)

33917 (COO–1198-870) DISPLACIVE TRANSFORMATIONS IN NEAR-EQUIATOMIC NIOBIUM–RUTHENIUM ALLOYS. II. ENERGETICS AND MECHANISM. Das, Bijoy K.; Lieberman, David S. (Illinois Univ., Urbana); Stern, Edward A. (Technion-Israel Inst. of Tech., Haifa). [1972]. Contract AT(11-1)-1198. 39p. Dep. NTIS.

The transformation distortions during the $\beta \rightarrow \beta'$ and $\beta' \rightarrow \beta''$ transformations near equiatomic Nb–Ru alloys produce phases that have progressively lower symmetry than the CsCl type β phase and approach the packing of the hexagonal close packed structure. By the use of a new and simple approximation—the superposition approximation—a model is developed which explains all of the experimental measurements on this alloy system. The driving force for these transformations is electronic in nature. The Fermi energy μ of the β-phase alloys is near a sharp peak in the density of states, $\rho(E)$. The transformations broaden this peak, lowering $\rho(\mu)$ and the energy of the phase. The significant experimental measurements accounted for by this model are the variation in magnetic susceptibility with phase and Ru content, and the variation of transformation temperatures and transformation distortion with Ru composition and distortion in the β''-phase with temperature and Ru composition. From this analysis and a brief consideration of a quite different alloy, there seems to be no a priori reason why the new super position approximation should not be applicable to all alloys systems. (auth)

33918 (JPRS–55848) ELECTRON TRANSFER OF CARBON IN BERYLLIUM. Gladkov, V. P.; Zotov, V. S.; Skorov, D. M. Translated from At. Energ. (USSR); 32: No. 2, 163-4(1972). 4p. NTIS.

The electron transfer of carbon in polycrystalline beryllium with a grain size of 56 microns was studied. The effective electric charges in the beryllium were determined at 1273, 1373, and 1473°K equal to −26.5, −0.154 and −0.264, respectively. The natural electric charge of carbon in the beryllium was calculated in the approximation of a two-zone model of a solid state ($z_i = -2$ for the range of 1373 to 1473°K). It is proposed that solid substitution solutions can exist in the beryllium-carbon system. (JPRS)

33919 (LIB-Trans-399) RELATION BETWEEN STRAIN AGEING OF α-ZIRCONIUM AND THE ANISOTROPIC SHORT DISTANCE DIFFUSION OF OXYGEN. de Paula e Silva, E.; Com-Nougue, J.; Beranger, G.; Lacombe, P. Translated by W. Buykx (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Scr. Met.; 5: No. 9, 795-800 (1971). 9p. Dep. NTIS (U. S. Sales Only).

An abstract of this item prepared from the original appeared as NSA 25: 55551. (Australia)

33920 (ORNL–4764) HEAVY-SECTION STEEL TECHNOLOGY PROGRAM. Semiannual Progress Report for Period Ending August 31, 1971. (Oak Ridge National Lab., Tenn.). Apr 1972. Contract W-7405-eng-26. 74p. Dep. NTIS.

The Heavy-Section Steel Technology (HSST) Program is concerned with the primary vessels for water reactors, with the main emphasis being placed on the effects of flaws, material inhomogeneities, and discontinuities on the behavior of the vessels under normal operating and accident conditions. The program is coordinated with efforts by the manufacturing and utility sectors of the nuclear power industry to assess the in-service structural safety of the massive pressure vessels typical of those used in boiling- and pressurized-water reactor systems. In the HSST program, particular emphasis is placed on developing a technology that can be used to establish the margin of safety against failure of the vessels, particularly catastrophic failure beyond the control of plant safety features. Research progress is reported in sections on characterization of unirradiated materials and properties of irradiated materials. Results of pressure vessel testing and examination are included. (J.R.D.)

33921 (UCRL-Trans–10612) UTILIZATION OF THE KAGENER METHOD FOR THE MEASUREMENT OF THE AREAS OF METALLIC FILMS BY ISOTHERMIC ADSORPTION OF Kr, Xe, AND CH_4. Delaunois, Y.; Frennet, A.; Lienard, G. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from J. Chim. Phys.; 63: No. 6, 906-15(1966). 23p. Dep. NTIS.

The adsorption isotherms of Kr, Xe, and CH_4 were measured on evaporated films of Ti, Ta, Mo, Re, Rh, Pt, and Pd. The number of molecules in the monolayer is the same, independently of the method of Bet or Kaganer. It is shown that the use of the Bet equation at pressures corresponding to coverages lower than the monolayer gives lower area values. Literature results are discussed. An adsorption model in the monolayer is proposed based on an hexagonal lattice for krypton and xenon, and a square lattice for methane. The hydrogen chemisorption scarcely represents a good criterion to compare metallic films areas. (auth)

33922 STRENGTHENING OF MOLYBDENUM AND TUNGSTEN ALLOYS WITH HfC. Klopp, W. D.; Raffo, P. L.; Witzke, W. R. (Lewis Research Center, Cleveland). J. Metals; 23: No. 6, 27-38(Jun 1971).

Studies were made on the potential of HfC strengthening of Mo and W alloys. The results showed that strength improvements up to 9-fold can be achieved by alloying Mo and W with HfC. The optimum amounts of HfC are 0.35 mole % in W and probably 0.8 to 0.9 mole % in Mo. Thermomechanical processing studies on Mo–Hf–C suggest that the optimum structure for high-temperature strength can be obtained by extruding at the temperature of maximum carbon solubility, 4000°F, followed by warm swaging at 2500°F. This produces a highly worked structure stabilized by a fine HfC precipitate. The presence of the HfC precipitate has only a minor effect on low temperature ductility of both Mo and W. The ductility of W–Hf–C can be improved by the addition of 4 at. % Re. Carbide coarsening studies on W–Re–Hf–C alloys indicated that carbide strengthened W alloys should be stable for thousands of hours at 3000°F ($0.52T_m$) but only a few hours at 4000°F ($0.67T_m$). (P.C.H.)

33923 THERMAL STRESSES AND THERMAL FATIGUE. Proceedings of the International Conference Held at Berkeley Castle, England, September 22-26, 1969. Littler, D. J. (ed.). London; Butterworths (1971). 576p. Pound 20. (CONF-690987).

Thirty-three papers were presented at the conference. A separate abstract was prepared for three papers. The remaining papers, not within the scope of NSA, contain information on the behavior of materials under cycle loading at high temperatures, experimental measurement and theoretical analysis of thermal stresses, and the application of research to power plants. (UK)

For abstracts of individual papers see: 33924, 33925, and 35452.

33924 LOW-CYCLE FATIGUE OF ½Cr–½Mo–¼V STEEL (CSN 415123). Vokoun, V.; Kaisler, L. (Inst of Nuclear Research, Prague). 124-7 of Thermal Stresses and Thermal Fatigue. /Littler, D. J. (ed.). London; Butterworths (1971).

From Thermal stresses and thermal fatigue conference; Berkeley Castle, England (22 Sep 1969).

For the primary piping of the first Czechoslovak Atomic Power Station (A1) CSN 415123 steel was used. This is a ½Cr–½Mo–¼V material, heat treated to produce bainitic structure. This report contains some results of low cycle fatigue tests on this material. Experiments were performed on small tubular specimens, subjected to uniaxial cyclic stress and uniaxial cyclic strain to two temperature levels. The methods of testing are described and results are presented for the material in two conditions of heat treatment. Good correlation is obtained between test results and theoretically predicted endurances. (auth)

33925 EFFECT OF REST PERIODS ON THE ACCUMULATION OF HIGH TEMPERATURE FRACTURE DAMAGE. Walker, G. K.; Evans, H. E.; Waddington, J. S. (Central Electricity Generating Board, Berkeley, Eng.). pp 157-62 of Thermal Stresses and Thermal Fatigue. /Littler, D. J. (ed.). London; Butterworths (1971).

From Thermal stresses and thermal fatigue conference; Berkeley Castle, England (22 Sep 1969).

Work on 20Cr–25Ni–Nb stainless steel is presented which shows that annealing of high temperature (i.e. $\gtrsim 0.45\ T_m$, where T_m is the melting point in °K) fracture damage can occur at the temperature of straining. The removal of this damage results in concurrent increases in ductility. The important parameters affecting the rate of damage annealing are discussed briefly. A modified cumulative damage rule is suggested which takes into account the damage annealing phenomenon. It is shown that unless allowance is made for this effect, the endurance of high temperature components can be underestimated. (auth)

33926 RECOVERY OF DEFORMED ZIRCONIUM ABOVE ROOM TEMPERATURE. Pande, B. M.; Anand, M. S.; Agarwala, R. P. (Bhabha Atomic Research Centre, Trombay, India). Phys. Status Solidi (a); 10: No. 2, K137-9(16 Apr 1972).

A study was made of the resistometric recovery of deformed Zr in isochronal anneals at temperatures from 52 to 450°C. The recovery is continuous with no peaks. The continuous recovery may be due to recovery of dislocations formed during the deformation; if so, the dislocation density is very high. (D.L.C.)

33927 THERMAL CONDUCTIVITY OF THULIUM IN THE TEMPERATURE RANGE FROM 0.5 TO 4.5 K. Janos, S.; Feher, A. (Safarik Univ., Kosice, Czech.). Phys. Status Solidi (a); 10: No. 2, K153-4(16 Apr 1972).

The thermal conductivity of 99.9% pure Tm was measured at 0.5 to 4.5°K. The conductivity was found to be separable into a linear (αT) and a quadratic (βT^2) term, with $\alpha = 1.06$ mW/cm deg^2 and $\beta = 0.245$ mW/cm deg^3. (D.L.C.)

33928 ELECTRON MICROSCOPE STUDY OF THE DEVELOPMENT OF A CELLULAR STRUCTURE IN MOLYBDENUM DURING HYDRO-EXTRUSION. Pryanishnikov, M. P.; Trofimova, L. N.; Shklyarenko, V. P. (Inst. of Metal Physics, Kiev). Metallofizika; No. 37, 76-83(1971). (In Russian).

A regularity in the formation of a cellular structure in molybdenum was noted during hydroextrusion. The quantitative characteristics of this process were investigated. Cell dimensions and azimuthal angles of disorientation were expressed as functions of the degree of deformation. The electron microscopic pattern is interpreted in terms of cell formation. (tr-auth)

33929 CALORIMETRIC MEASUREMENTS OF THE HEAT OF SOLUTION OF Gd IN Sn. DETERMINATION OF THE ENTHALPY OF FORMATION OF $GdSn_3$. Bacha, Abderrahman; Chatillon-Colinet, Catherine; Percheron, Annick; Mathieu, J. C. (Ecole Nationale Superieure d'Electrochimie et d'Electrometallurgie, Grenoble, France. Centre National de la Recherche Scientifique, Meudon, France). Compt. Rend., Ser. C; 274: No. 7, 680-3(14 Feb 1972). (In French).

The heat of solution of Gd in Sn was measured at 969°K, the partial enthalpy limit of Gd at this temperature being subsequently determined (−41.9 kcal/g-at.). The heat of solution of $GdSn_3$, which crystallizes in the fcc system with a 4.67 Å parameter was determined. The heat of formation of $GdSn_3$ was deduced (−49.65 kcal/mole), the partial enthalpy of Gd being taken into consideration. (France)

33930 THERMODYNAMIC PROPERTIES OF LIQUID ALLOYS IN THE SODIUM–INDIUM SYSTEM. Morachevskii, A. G.; Bykova, M. A.; Maiorova, E. A. (Leningrad Polytechnic Inst.). J. Appl. Chem. USSR (Engl. Transl.); 44: No. 10, 2369-71(Oct 1971).

Translated from Zh. Prikl. Khim.; 44: No. 10, 2317-19(Oct 1971).

Studies on the In–Na system revealed considerable negative deviations from ideal behavior, and absence of a region of phase separation was confirmed. (auth)

33931 PROPERTIES OF ELECTROLYTIC CHROMIUM–MOLYBDENUM ALLOYS. Shluger, M. A.; Shirokova, N. V. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 10, 2387-8 (Oct 1971).

Translated from Zh. Prikl. Khim.; 44: No. 10, 2328-30(Oct 1971).

Studies were made on the effects of composition of Cr–Mo coatings on their properties. The microhardness of Cr–Mo alloy deposits reached 800 to 1000 kg/mm^2. At higher Mo contents in the deposits the current density had considerably less influence on microhardness of the coatings. A correlation was found between variations of microhardness and internal stresses in alloy deposits with different Mo contents. An increase in the Mo content in the alloy led to some decrease in microhardness and formation of less stressed deposits. Coatings with more uniform microstructure were obtained when the Mo contents of the alloys were increased. (auth)

33932 HOW COPPER SURFACE CONTAMINATION AFFECTS WELDABILITY OF COBALT SUPERALLOYS. Matthews, S. J. (Cabot Corp., Kokomo, Ind.); Maddock, M. O.; Savage, W. F. Weld. J. (N. Y.); 51: No. 5, 326-8(May 1972).

Studies were made to illustrate the effects of copper surface contamination on the hot crack susceptibility of Co-base alloys. The results showed that as the Co in the base-metal increased, sensitivity to cracking due to copper surface contamination also increased. Identical spot welds deposited in areas of each specimen without copper surface contamination produced no heat affected zone (HAZ) cracking. It is suggested that the presence of relatively small amounts of Cu inadvertently transferred to the surface of Co superalloys during assembly into Cu welding fixtures may be responsible for the gross microcracking that has been observed in these materials, especially when welding thin gauge sheet under appreciable restraint. A simple solution to this condition would be to utilize Cr plated welding fixtures to minimize the chance of Cu surface contamination in the weldment area. (P.C.H.)

33933 LOW-TEMPERATURE HEAT CAPACITY OF β-CERIUM AND β-CERIUM–YTTRIUM ALLOYS. Panousis, N. T.; Gschneidner, K. A. Jr. (Iowa State Univ., Ames). Phys. Rev., B; 5: No. 12, 4767-74(15 Jun 1972).

The low-temperature heat capacities of a nearly pure β-cerium sample ($91\%\beta - 9\%\alpha$) and six β-stabilized Ce–Y alloys were determined between 2.5 and 20°K. Three principal results were obtained. (i) All six alloys showed magnetic ordering characteristic of β-cerium; the ordering temperatures decreased linearly with yttrium concentration. (ii) The magnetic contribution to the heat capacity of β-cerium was found to depend on the cube of the temperature in agreement with spin-wave theory for an antiferromagnetic material. (iii) The entropy associated with magnetic ordering was found to be R ln2; it is consistent with a crystal field splitting of the $J = {}^5\!/_2$ multiplet into three doublets by the hexagonal lattice. (auth)

33934 IMPURITY DIFFUSION IN CADMIUM. Mao, Chih-wen (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., B; 5: No. 12, 4693-4704(15 Jun 1972).

Diffusion of impurities in single crystals of cadmium was studied by tracer-sectioning techniques. For heterovalent diffusion the diffusion coefficients, in cm^2/s, are given by $D_{||}(\mathrm{In}) = \exp(-2.29 \pm 0.20) \exp[-(17.45 \pm 0.19)1000/RT]$, $D_{\perp}(\mathrm{In}) = \exp(-2.41 \pm 0.16 \exp[-(16.94 \pm 0.15)1000/RT]$, $D_{||}(\mathrm{Ag}) = \exp(0.34 \pm 0.47) \exp[-(24.64 \pm 0.48)1000/RT]$, $D_{\perp}(\mathrm{Ag}) = \exp(-0.39 \pm 0.62) \exp[-(25.07 \pm 0.65)1000/RT]$, $D_{||}(\mathrm{Au}) = \exp(0.34 \pm 0.08) \exp[-(25.47 \pm 0.08)1000/RT]$, and $D_{\perp}(\mathrm{Au}) = \exp(1.15 \pm 0.22) \exp[-(26.43 \pm 0.22)1000/RT]$. The activation energies obtained in this study could be interpreted with LeClaire's screening model. Good agreement between experimental results and theoretical estimates was obtained. For homovalent diffusion (including self-diffusion), the results are $D_{||}(\mathrm{Zn}) = \exp(-2.04 \pm 0.26) \exp[-(18.03 \pm 0.25)1000/RT]$, $D_{\perp}(\mathrm{Zn}) = \exp(-2.48 \pm 0.24) \exp[-(18.02 \pm 0.24)1000/RT]$, $D_{||}(\mathrm{Cd}) = \exp(-2.14 \pm 0.13) \exp[-(18.61 \pm 0.12)1000/RT]$, $D_{\perp}(\mathrm{Cd}) = \exp(-1.70 \pm 0.19) \exp[-(19.59 \pm 0.19)1000/RT]$, $D_{||}(\mathrm{Hg}) = \exp(-1.55 \pm 0.07) \exp[-(18.78 \pm 0.06)1000/RT]$, and $D_{\perp}(\mathrm{Hg}) = D_{||}(\mathrm{Hg})$. It is felt that valence and size effects are in competition for homovalent diffusion. The size effect appears dominant in the case of Cd as the base metal, whereas for Zn as the base metal the valence effect seems to dominate. A preliminary study of the isotope effect of Zn in Cd was also conducted. The resulting values of E for diffusion parallel and perpendicular to the c axis were 0.4388 ± 0.0495 and 0.6829 ± 0.1023 at 199.3°C. These results seem to rule out the interstitial mechanism as the dominant mechanism in agreement with the usual assumption that the vacancy mechanisms (basal and nonbasal) prevail for the hexagonal metals. (auth)

33935 STABILITY OF THE $CaCu_5$ PHASE IN COMPOUNDS FORMED BETWEEN YTTRIUM AND THE 3d-ELEMENTS. Taylor, K. N. R.; Poldy, C. A. (Univ. of Durham, Eng.). J. Less-Common Metals; 27: No. 2, 255-7(May 1972).

Studies were made on the properties of compounds with basic formulas $Y(Co,Ni)_5$ and $Y(Co,Fe)_5$ in the respective pseudobinary systems. Complete solubility was observed in the $Y(Co,Ni)_5$ systems with a smooth variation of the lattice parameters across the series. With the substitution of Fe into YCo_5 the lattice parameters changed rapidly, the c spacing increased and the a spacing decreased. With the addition of 40 at. % Fe there was no evidence of the $CaCu_5$ phase in the x-ray patterns and even with 30 at. % the presence of impurity phases was evident. The rapid increase in the axial spacing of specimens containing Fe may be considered as a tensile distortion of the YCo_5 lattice and is undoubtedly associated with the structural instability. Both YCo_5 and YNi_5 posses the $CaCu_5$ structure, and the results for the specimens formed between these terminal compounds suggest that there is substitutional replacement of Co by Ni in making the pseudobinary systems. The rapid deviation that occurred once Fe was introduced into YCo_5 suggests that the situation may become more complex. It is proposed that in addition to an Fe–Co substitution there is also a partial replacement of Y ions by pairs of Fe ions aligned parallel to the c axis. (P.C.H.)

33936 SOLUBILITIES OF THORIUM AND NEODYMIUM IN LIQUID LITHIUM–BISMUTH SOLUTIONS. Smith, F. J. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals; 27: No. 2, 195-200(May 1972).

The solubility of neodymium in bismuth and the solubilities of thorium and neodymium in several liquid lithium–bismuth alloys have been determined between the solidus temperature of each alloy and about 700°C. The solubility of thorium in lithium–bismuth solutions increased regularly as the lithium concentration in solution increased from 0 to about 40 at. %. The apparent heat of solution was 14.8 ± 0.4 kcal/g-atm Th for each lithium–bismuth solution. Similarly, the solubility of neodymium increased from 0 to 25 at. %, with an apparent heat of solution of 11.7 ± 0.8 kcal/g-atm Nd. However, when the lithium concentration was increased from 25 to 38 at. %, the heat of solution decreased to about 8.6 kcal/g-atm Nd. Activity coefficients for neodymium and thorium in the lithium–bismuth solutions have been estimated from the solubility data. (auth)

33937 MODIFIED MODEL FOR THE SINTERING OF TUNGSTEN WITH NICKEL ADDITIONS. Gessinger, G. H. (Brown Boveri Research Center, Baden, Switzerland); Fischmeister, H. F. J. Less-Common Metals; 27: No. 2, 129-41(May 1972).

A geometrical model for sintering nickel-doped tungsten is proposed which consists of a pendular ring at the tungsten neck surface plus a nickel-enriched tungsten grain boundary. As compared to Kingery's model, the force equation contains two additional terms to account for the effect of surface tension at the nickel–vapor interface, and the effect of the interfacial tension, γ_{WNi}, at the tungsten surface, including a factor for the dihedral angle. Nickel does not wet tungsten completely. The contact angle at 1200°C, as determined by scanning electronmicroscopy, is 35°. Therefore, wetting is restricted to places of suitable geometry, especially grain boundaries. The activating effect of nickel on the sintering of 0.5 μm tungsten powder at 1000°C is due to the enhancement of grain boundary self-diffusion in tungsten. At 1100°C an additional contribution for rearrangement has to be considered. The behavior of nickel at elevated temperatures on tungsten surfaces is qualitatively similar for flat tungsten surfaces and tungsten particles. In order to obtain a homogeneous nickel distribution in the tungsten compact, nickel has to be added by evaporation or in the form of chemical solution. Complete homogenization is not possible with tungsten–nickel powder mixes. (auth)

33938 EFFECT OF OXYGEN CONTAMINATION ON THE TENSILE PROPERTIES OF T-111 (TANTALUM–8TUNGSTEN–2HAFNIUM) AT 1204°C. Etter, D. E.; Smith, W. H. (Monsanto Research Corp., Miamisburg, Ohio). J. Less-Common Metals; 27: No. 2, 109-22(May 1972).

An investigation of the effects of contamination of T-111 (Ta–8W–2Hf) with up to 6000 ppM of oxygen showed that 2400 ppM can be dissolved at 1400°C without impairing its mechanical properties at 1204°C. Under the prescribed conditions T-111 could be homogeneously contaminated with oxygen only at levels of 3600 ppM and above. Below this level T-111 exhibited a stable reaction zone which was proportional to the oxygen concentration. The reaction zone contained a precipitate which was identified as HfO_2. (auth)

33939 CRYSTAL STRUCTURE OF $YbCu_{6.5}$. Hornstra, J.; Buschow, K. H. J. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals; 27: No. 2, 123-7(May 1972)

The crystal structure of $YbCu_{6.5}$ has been determined from powder data with the use of difference Fourier syntheses. It is related to the $CaCu_5$ structure, but 18% of the Ca sites are occupied by pairs of Cu atoms. The magnetic susceptibility and the lattice constants showed that Yb is divalent in this compound. (auth)

33940 THERMODYNAMIC FUNCTIONS FOR THE α SOLID SOLUTION IN THE SYSTEM NIOBIUM–MOLYBDENUM–NITROGEN. ACTIVITY COEFFICIENTS, EXCESS PARTIAL QUANTITIES, AND INTERACTION COEFFICIENTS. Hoerz, G.; Steinheil, E. (Max-Plank-Institut fuer Metalforschung, Stuttgart). J. Less-Common Metals; 27: No. 2, 243-50(May 1972).

On the basis of experimental results, part of which have been published previously, (Hoerz and Steinheil, J. Less-Common Metals, 21: 84(1970)) activity coefficients, excess partial quantities and interaction coefficients for the solution of nitrogen in niobium–molybdenum alloys were derived by means of which the effects of molybdenum on the solubility of nitrogen in niobium or the effects of niobium on the solubility of nitrogen in molybdenum are quantitatively described. For temperatures between 1600 and 2400°C and for nitrogen concentrations in the range of the α niobium–molybdenum–nitrogen solid solution the following equations were obtained: $\chi_N = p_{N_2}^{1/2} \exp [(-17.6 + 4.6\chi_{Mo})/R] \exp [-(-46.0 + 38.6\chi_{Mo}) \cdot 10^3/RT]$ for $\chi_{Mo} \leqq 0.4$ and $\chi_N = p_{N_2}^{1/2} \exp [(-6.3 - 18.7\chi_{Nb})/R] \exp [-(19.9 - 93.3\chi_{Nb}) \cdot 10^3/RT]$ for $\chi_{Nb} \leqq 0.4$. Here χ_N, χ_{Mo}, and χ_{Nb} denote the atom fraction of nitrogen, molybdemum, and niobium in the α solution; p_{N_2} is the nitrogen pressure in atm, T the absolute temperature in °K, and R the gas constant. (auth)

33941 COMPOUNDS AND PSEUDO-BINARY ALLOYS WITH THE $CuAl_2$(C16)-TYPE STRUCTURE. II. THEORETICAL DISCUSSION OF CRYSTALLOGRAPHIC PARAMETERS. Havinga, E. E. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals; 27: No. 2, 187-93(May 1972).

A qualitative explanation in terms of band structure effects is given for the observed oscillatory dependence of the c/a ratio of C16-type compounds and alloys on the concentration of valence electrons. The fact that the χ-parameter more or less follows the oscillations in the c/a ratio is explained in a semi-quantative way with the help of a model that considers the atoms as elastic balls. (auth)

33942 COMPOUNDS AND PSEUDO-BINARY ALLOYS WITH THE $CuAl_2$(C16)-TYPE STRUCTURE. I. PREPARATION AND X-RAY RESULTS. Havinga, E. E.; Damsma, H.; Hokkeling, P. (Philips Research Labs., Eindhoven, Netherlands). J. Less-Common Metals; 27: No. 2, 169-86(May 1972).

A total of 46 binary compounds with the $CuAl_2$(C16)-type structure have been prepared and their crystallographic properties (unit cell dimensions a and c and the atomic coordinate χ) have been measured. Two new examples $FeZr_2$ and $GaTh_2$ are included. The existence of four compounds claimed to exist in this structure-type, viz., $AlZr_2$, $AlHf_2$, BCr_2, and $RuSn_2$, could not be confirmed. Moreover, data are presented for 11 pseudo-binary alloy systems showing complete solid-solution series, and for 12 other systems with limited regions of the $CuAl_2$-type structure. The results show that c/a is markedly dependent on the valence electron concentration, while the χ-parameter more or less follows the oscillations in the c/a-ratio. (auth)

33943 STUDY OF THIN FILMS OF YTTERBIUM BY X-RAY AND ELECTRON DIFFRACTION: DIRECT OBSERVATION OF THE fcc ⇌ hcp MARTENSITIC TRANSFORMATION; STUDY OF PHASE STABILITY. Boulesteix, C.; Nevot, L.; Renard, D.; Valiergue, L.; Gasgnier, M. (Faculte des Sciences, Orsay, France). Thin Solid Films; 10: No. 2, 229-42(May 1972). (In French).

Two types of structure, fcc and hcp were observed in thin films of ytterbium by x-ray- and electron-diffraction methods, after annealing in a vacuum up to 740°K. The x-ray-diffraction pattern demonstrated the existence of a very strong preferential orientation for the hcp structure (mean disorientation 1.85°). The martensitic transformation hcp ↔ fcc observed by electron microscopy and electron diffraction was similar to that for cobalt. (auth)

33944 LEED AND WORK FUNCTION STUDY OF Cs AND O ADSORPTION ON W(112). Papageorgopoulos, C. A.; Chen, J. M. (Franklin Inst., Swarthmore, Pa.). J. Vac. Sci. Technol.; 9: No. 2, 570-4(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Adsorption of Cs and O on W(112) was studied with systematic variations of the composition and the sequence of deposition of the adsorbates. The results suggest that Cs and O form a W/O/Cs double layer, regardless of the sequence of deposition. The differences in structure of Cs on clean W and O/W are compared. It is found that Cs and O affect the structures of each other. The change in work function of the surface at various Cs and O coverages is reported. Throughout the coverage range of the present study, there is no apparent evidence of cesium oxide formation. (auth)

33945 SIMULTANEOUS SIMS, EID, AND FLASH-FILAMENT INVESTIGATIONS OF THE INTERACTION OF GASES WITH A TUNGSTEN SURFACE. Benninghoven, A.; Loebach, E.; Treitz, N. (Univ., Cologne). J. Vac. Sci. Technol.; 9: No. 2, 600-2(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

A uhv system, containing a heatable (up to >2600°K) W ribbon target, a Finkelstein ion source (Ar^+, 2 keV) with magnetic mass separator, an electron source (300 eV), a quadrupole secondary ion mass filter with a counting channel electron multiplier and a quadrupole gas analyzer, is used for the study of the adsorption and desorption of H_2, O_2, and Co on W by simultaneous, i.e., fast interchanging "static" SIMS [secondary (ion-induced) ion mass spectroscopy] and EID [electron-impact desorption] and by flash-filament measurements. Different binding states can be distinguished. The emission cross sections of the adsorbate–specific ions by ion bombardment depend far less upon the gas exposure (and therefore upon the coverage) than those corresponding to electron bombardment. (auth)

33946 ADSORPTION AND FLASH DECOMPOSITION OF ETHYLENE ON TUNGSTEN SINGLE-CRYSTAL FACES. Barford, B. D.; Rye, R. R. (Cornell Univ., Ithaca, N. Y.). J. Vac. Sci. Technol.; 9: No. 2, 673-7(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

The interaction of ethylene with the (100), (110), (111), and (211) faces of tungsten was studied by means of thermal desorption spectroscopy. Ethylene decomposition yields a single broad hydrogen peak at ~300°K on W(111), two poorly resolved hydrogen peaks at ~300 and ~400°K on W(211), hydrogen peaks at ~300 and ~450°K with an area ratio of 1:2 on W(110), and a single decomposition peak at ~275°K on W(100). Assuming di-σ-bonded ethylene, these results are consistently interpreted in terms of the limitations on ethylene adsorption imposed by the structure of the surface, and the stability of adsorbed ethylene is interpreted from consideration of the structure of the resulting ethylene–surface complex. The absence of two equal peaks on all except the (211) face eliminates the possibility of a two-step decomposition suggested by previous work. (auth)

33947 STUDY OF ADSORPTION AND NUCLEATION OF CADMIUM ON TUNGSTEN AND GERMANIUM BY A MOLECULAR BEAM TECHNIQUE. Voorhoeve, R. J. H.; Wagner, R. S.; Carides, J. N. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Vac. Sci. Technol.; 9: No. 2, 780-3(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Polycrystalline tungsten, and several germanium single-crystal faces, such as (111), (110), (211) etc., were bombarded with a calibrated cadmium beam of thermal energy. Various adsorption states were revealed by continuously monitoring cadmium evaporated from the substrate. Multilayer adsorption was found to precede growth of bulk cadmium for both types of substrate. The extent of this adsorption is 3 to 4 monolayers on tungsten and 2 monolayers on germanium (111). The heat of adsorption varies from 27 to 51 kcal/mole for tungsten, and is 25 to 32 kcal/mole for germanium. The nucleation of bulk cadmium was studied with the same technique. Monitoring the evaporated cadmium during deposition allowed determination of the critical adatom coverage at which nucleation of bulk cadmium occurred. The nucleation kinetics shows critical behavior on germanium substrates but not on clean tungsten. (auth)

33948 FIELD ION MICROSCOPY OF VAPOR-DEPOSITED PLATINUM ON TUNGSTEN. Raghavan, N. V. Durai; Bayuzick, R. J. (Vanderbilt Univ., Nashville). J. Vac. Sci. Technol.; 9: No. 2, 784-7(Mar-Apr 1972).

$_{25}$From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Platinum was vapor-deposited on tungsten under high vacuum conditions. The resultant thin films were then examined in the field-ion microscope at 78°K. The platinum deposits were obtained under three different conditions. Deposits on substrate held at 78°K gave several localized but crystalline deposits which were 10 to 100 Å in diameter and approximately 25 Å thick. A short anneal of the substrate at 1100°K, after deposition was performed at 78°K, resulted in evidence for the existence of a pseudomorphic deposit of platinum on tungsten, less than 10 Å in thickness. Deposition at 1100°K followed by annealing at 1100°K resulted in appreciable bulk diffusion and the field ion images obtained were typical of those from alloys. (auth)

33949 APPLICATION OF VARIOUS METHODS FOR THE DETERMINATION OF ADSORPTION LIFETIME AND DESORPTION ENERGY OF OXYGEN ON TUNGSTEN. Wassmuth, H.-W.; Werner, H.; Mazumdar, A. K. (Univ., Marburg, Ger.). J. Vac. Sci. Technol.; 9: No. 2, 835-9(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

The adsorption lifetime τ and the desorption energy Q of oxygen atoms on a polycrystalline tungsten surface were determined as functions of the coverage θ by using a uhv mass spectrometer. A method based on contact potential and sticking probability measurements (T = 1200 to 2500°K), a combined study of steady-state and transient-state desorption processes (T = 2000 to 2600°K), and three different types of flash desorption measurements under single flight detection conditions (T = 1900 to 2600°K) were employed. Satisfactory agreement of the results obtained from the different methods was observed. A compensation effect, depending on the coverage θ, was found between the pre-exponential factor of τ and the desorption energy Q which varies between 6.3 eV at $\theta = 0$ to 3.4 eV at $\theta = 1$. (auth)

33950 LEED/AUGER SPECTROSCOPY STUDY OF THE ADSORPTION OF ALKALI METALS ON Mo(110). Thomas, S.; Haas, T. W. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Vac. Sci. Technol.; 9: No. 2, 840-3(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

LEED and Auger electron spectroscopy (AES) were used to study the adsorption of Na, K, Rb, and Cs on a Mo (110) surface. Alkali ions were deposited (at room temperature; pressure $<1 \times 10^{-10}$ torr) from zeolite ion sources which enabled the absolute coverage to be measured. Peak–peak heights of ^{47}Cs, ^{251}K, ^{56}Rb, and 75 eV Auger peaks and of Mo Auger lines were monitored as a function of coverage. Quantitative estimates of Na adsorption could not be made using AES owing to the low Auger yield of Na. LEED patterns showed a hexagonal-close-packed arrangement of the alkalis on Mo(110). (auth)

33951 ADSORPTION OF OXYGEN ON THE (100) PLANE OF TUNGSTEN. Bacal, M. (Institut de Physique Nucleaire, Orsay, France); Desplat, J. L.; Alleau, T. J. Vac. Sci. Technol.; 9: No. 2, 851-6(Mar-Apr 1972).

From International Conference on solid surfaces; Boston, Mass. (11 Oct 1971).

The effect of oxygen adsorption on the (100) tungsten surface was investigated in a thermionic electron emission microscope and by means of contact potential measurements (Kelvin method). Surface contamination was closely controlled. The measurements indicate that the work function versus oxygen pressure curves agree with those of Batzies. The oxygen desorption energy decreases with increasing oxygen coverage. The initial sticking coefficient S_0, slope $(d\Delta\phi/dn)_0$ and dipole moment μ_D deduced from the experimental results are $S_0 = 0.17$, $d(\Delta\phi/dn)_0 = 4.3 \times 10^{-15}$ eV at.$^{-1}$ cm^2, $\mu_D = 2.2$ D. (auth)

33952 DETERMINATION OF ADSORBATE STRUCTURES ON METAL SURFACES: ALKALIS, RARE GASES, AND HYDROGEN ON TUNGSTEN. Schmidt, L. D. (Univ. of Minnesota, Minneapolis). J. Vac. Sci. Technol.; 9: No. 2, 882-9(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Information needed for characterization of adsorbate structures is discussed, and the experimental situation is summarized for three much studied prototype systems: alkali metals, rare gases, and H_2 on individual crystal planes of W. While fairly complete pictures of these systems emerge, notable gaps and contradictions remain. The number of distinct states on the surface has not been established for alkali metals and rare gases on most planes. LEED patterns for Cs and H_2 on (100) W have not yet been correlated with amounts and binding states determined by other methods. The alkali metals and rare gases are remarkably similar in dipole moment and relative binding energies on different crystal planes. Structures of these systems appear to be determined by substrate geometry, and bonding can be explained reasonably well on the basis of van der Waals and electrostatic forces. For hydrogen, the number of states cannot be predicted from substrate geometry alone nor can the relative binding energies be explained from known forces. Still lacking for all of these systems are unequivocal determination of the adsorption sites and the charges on the adsorbates. (auth)

33953 QUANTITATIVE ANALYSIS OF THERMAL DESORPTION SPECTRA: CHEMISORPTION OF CARBON MONOXIDE ON TUNGSTEN. Winterbottom, W. L. (Ford Motor Co., Dearborn, Mich.). J. Vac. Sci. Technol.; 9: No. 2, 936-41(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Numerical analysis of the line shapes of thermal desorption spectra for CO on polycrystalline tungsten was carried out. The results show that within the β phase, there are at least six chemisorption substates; desorption from five of these states is a simple, first-order process. It was demonstrated that the desorption technique is capable of resolving surface states whose heats of activation for desorption differ by as little as 4 kcal/mole. The experimental frequency factors for the five first order states increase with increasing activation energy. All the results can be interpreted as indicative of a highly directional bonding that is not closely related to the crystallographic anisotropy of the tungsten surface. (auth)

33954 GRAVIMETRIC METHOD OF LATTICE EXPANSION FOR THE MEASUREMENT OF HYDROGEN DIFFUSION IN TANTALUM. Wicke, E.; Obermann, A. (Univ., Muenster, Ger.). Z. Phys. Chem. (Frankfurt); 77: No. 1-6, 163-75(1972). (In German).

It is shown that with a highly sensitive balance with a highly stable zero point, the diffusion of hydrogen in the lattice of a tantalum tube placed parallel to the balance beam may be followed. This effect rests principally upon the displacement of the lattice planes of the tantalum relative to the balance fulcrum, associated with diffusion (the lattice expands with increasing hydrogen concentration). The shift of the hydrogen atoms themselves, on the other hand, causes only a minor opposed weight effect. Provided certain boundary conditions are observed, the torque on the balance is a linear function of time; the rate of change is proportional to the diffusion coefficient, that is, to the mean value assumed for the concentration range along the diffusion path. Measurements were performed between 0 and 50°C at average hydrogen contents $\bar{n}$ (n = atomic ratio H/Ta) up to $\bar{n} = 0.14$. At 25°C values of 2.5 to $1.0 \cdot 10^{-6}$ cm^2/s were obtained, decreasing with rising hydrogen concentration. The activation energy amounted to 3.6 ± 0.3 kcal/mole. At larger hydrogen contents the straight Arrhenius plots showed sudden changes of slope corresponding to higher activation energies (influence of the β-phase). The results for the α-phase concurred with those from the Gorski effect and from x-ray data of the lattice expansion method. In comparison to results of spin-echo measurements—activation energy 1.6 ± 0.4 kcal/mole—there was a difference which remains to be explained. (auth)

33955 THERMAL EXPANSION OF TWO-PHASE TEXTURED COMPOSITIONS. Kozlova, R. F.; Rabkin, V. B. Porosh. Met., Akad. Nauk Ukr. SSR; No. 3, 82-9(Mar 1972). (In Russian).

The temperature and concentration dependences of thermal expansion of deformed two-phase compositions of the Mo–Cu type with a stable texture were studied. The results are discussed. It was found that materials with controlled thermal expansion can be produced on the base of two-phase compositions. (auth)

33956 SOME REGULARITIES OF SINTERING BINARY SYSTEMS WITH AN INFINITE MUTUAL SOLUBILITY. Fedorchenko, I. M.; Ivanova, I. I. (Inst. of Problems in Material Management, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 3, 273-6(Mar 1972). (In Ukrainian).

Shrinkage concentration dependence was studied in systems with complete mutual solubility (Co–Ni, Co–Fe, Fe–Ni). The shrinkage behavior was established to be in agreement with the concentration dependence of the mutual diffusion parameters—coefficients and energy of activation. The range of the sharp shrinkage minimum in the system Co–Ni was not connected with the Kirkendall effect, since the diffusion coefficient of Co and Ni was practically equal. (auth)

33957 PHASE DIAGRAM OF THE SYSTEM CHROMIUM–SCANDIUM. Svechnikov, V. M.; Kobzenko, G. F.; Ivanchenko, V. G. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 3, 266-8(Mar 1972). (In Ukrainian).

Cast and annealed alloys were studied in a complete concentration range by the methods of differential thermal, x-ray crystal and metallographic analyses and by measuring microhardness. The phase diagram was plotted with complete mixing in a liquid state and two non-variant equilibria—eutectic (1090°C) and eutectoid (990°C). Ultimate solubility of Sc in chromium at 1090°C was less than 2 at. % Sc. (auth)

33958 STUDY OF THE INDIUM–GOLD REACTION IN THE INDIUM–GOLD–MERCURY SYSTEM. Kozin, L. F.; Dergacheva, M. B. Tr. Inst. Org. Katal. Elektrokhim., Akad. Nauk Kaz. SSR; No. 2, 73-83(1971). (In Russian).

The potentiometric method was used to study the In–Au–Hg system. This confirmed the presence of two intermetallic compounds AuIn and Au_3In. The hydrostatic separation method showed that both these compounds have low solubility in Hg and precipitate. The AuIn component of this deposit floated up into the Hg but the Au_3In due to its different density remained as a deposit. The solubility products of these compounds at various temperatures were determined as well as the values of ΔG, ΔH, and ΔS. The kinetics and activation energies for the formation and decomposition of AuIn and Au_3In in Hg are given. (Referativnyi Zh.)

33959 MIXED ADSORPTION OF D_2 AND C_2H_4 ON POLYCRYSTALLINE TUNGSTEN. Cartier, P. G.; Rye, R. R. (Cornell Univ., Ithaca, N. Y.). J. Chem. Phys.; 56: No. 11, 5316-23(1 Jun 1972).

The adsorption and reaction of hydrogen and ethylene on polycrystalline tungsten were studied by means of flash filament spectroscopy. For an ethylene exposure just sufficient to form a monolayer on a bare surface, a D_2 covered surface adsorbs $\frac{1}{2}$ monolayer of ethylene without loss of D_2; for the inverse process, preadsorption of C_2H_4, no D_2 is adsorbed. In flash filament spectra taken subsequent to a dose of hydrogen followed by ethylene, the major gas phase products are hydrogen and small quantities of ethane. The hydrogen spectra contain peaks at 300°K (ethylene decomposition), 450°K (both ethylene decomposition and hydrogen desorption), and 650°K (hydrogen desorption) with H_2 predominant in the 300° peak and D_2 predominant in the high temperature peaks. Since coverage studies show that ethylene decomposition occurs via transfer of hydrogen to the surface where H_2 and D_2 are known to equilibrate, this concentration of isotopes in specific peaks indicates that C_2H_4 adsorption does not occur uniformly over the D_2-covered surface. These results are interpreted in terms of a surface composed of two regions: region A where D_2 and C_2H_4 coadsorb on independent sites, and region B where D_2 and C_2H_4 occupy the same sites. Arguments are presented for associating W(100) with region A and W(110) with region B. The production of ethane during the flash is consistent with a Langmuir–Hineshelwood mechanism with migration of hydrogen as the rate limiting step. (auth)

33960 INVESTIGATION OF LATTICE DISTORTIONS IN DEFORMED Fe–Ni–Mo ALLOY. Shirvaitis, A. I.; Yakimavichyus, I. A. Liet. Fiz. Rinkinys; 11: No. 3, 487-92(1971). (In Russian).

The substructure of deformed Fe–Ni–Mo alloy surface was investigated. By means of the harmonic analysis of intensity curves of x-rav-diffraction lines (111), (222), and (311) it was shown that lattice distortion and particle size in the alloy depend on the deformation of the sample. (auth)

33961 GAS CONTENT OF MOLYBDENUM CONTAINING CERTAIN OXIDES. Saksonova, L. N.; Burtsev, V. T.; Mozzhukhin, E. I.; Lantsman, L. O. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 90-4(1971). (In Russian).

The respective contents of oxygen, hydrogen, nitrogen, and carbon monoxide in samples of Mo taken from various sources were determined by a desorption technique. The added material admixed with the Mo samples was one of the following: dispersed lanthanum oxide, ZrO_2, or SiO_2, and the percent of additive ranged from 0.14 to 0.57%. These additives did not affect the kinetics of N_2 and H_2, but did affect the desorption kinetics of CO. The experimentally determined oxygen content was less than those values derived by other techniques. (K.S.W.)

33962 EFFECT OF HEAT TREATMENT ON ALLOY STRUCTURE AND PROPERTIES OF THE Ti–V SYSTEM. Lyasotskaya, V. S.; Kolachev, B. A.; Sovalova, E. G. (Moscow Aviation Tech. Inst.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 128-32 (1971). (In Russian).

Alloy compositions of the Ti–V system containing 4, 6, 8, 10, 12, 14, 16, and 25% V were quenched from 850 and 1,000°C in water, and then aged for 3 h at 200, 300, 400, and 500°C. X-ray examinations and hardness measurements were made of the structure, and dilatometric curves were constructed. Maximum strength developed in samples having a martensite structure after quenching and after disappearance of the α'' phase. The effects of the various combinations of thermal treatment were compared. (K.S.W.)

33963 EXPERIMENT PLANNING FOR THE STUDY OF TUNGSTEN ANHYDRIDE REDUCTION BY HYDROGEN. Lisovskii, D. I.; Ivanov, V. A.; Gutov, E. I. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 166-7(1971). (In Russian).

A mathematical model for the reduction of WO_3 by hydrogen was sought. The controlling factors entering into the process included the feed rate of WO_3 to the furnace, consumption rate of H_2, the temperatures at various furnace zones, the rpm of the revolving tube furnace, and the angle of tilt of the furnace. (K.S.W.)

33964 WETTING OF SOME HARD METALS BY MOLTEN ALKALI METALS. Kazakevich, Z. A.; Zhemchuzhina, E. A.; Zagonkin, V S. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 36-9(1971). (In Russian).

The wettability of surfaces of Mo, W, Al_2O_3, and BeO by molten Na, K, and K–23% Na alloy was investigated as a function of temperature up to 500°C. The results showed that wetting angles decreased linearly with an increase in temperature. (K.S.W.)

33965 REACTION OF ZrO_2 WITH C AT ELEVATED TEMPERATURES. Pavlov, Yu. A.; Manukhin, A. V.; Melekhin, V. F. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 5, 108-11(1971). (In Russian).

Experiments were conducted on the ZrO_2–graphite reaction: $ZrO_2 + 3C \rightarrow ZrC + 2CO$, using large-particle (1 mm) graphite powder, and by following the loss in weight of the sample with respect to elapsed time at a given temperature. The maximum reduction at 2,200°C was 52%, and at 2,400°C was 69%. The possibility of the formation of an oxycarbide, e.g., $ZrC_{0.75}O_{0.28}$, on the surface of the graphite under given conditions is discussed. (K.S.W.)

33966 POLYTHERMAL SECTION Ti–ΣMoNi (9:1) OF THE TERNARY SYSTEM Ti–Mo–Ni. Kalabukhova, S. V.; Mikheev, V. S. Porosh. Met., Akad. Nauk Ukr. SSR; No. 2, 33-7(Feb 1972). (In Russian).

The titanium angle of Ti–Mo–Ni system was investigated within the range of alloys rich in Mo. The investigations were carried out in the section with the ratio Mo : Ni = 9 : 1 up to the alloy composition with ΣMoNi = 55% by weight. On the basis of data from studies of the microstructure, hardness, resistivity, dilatometric measurements, and x-ray crystal analysis, the partial polythermal section Ti–ΣMoNi (9 : 1) is plotted. The dependences are presented of linear expansion on temperature resistivity—on the composition at 60 and 800°C and hardness—on temperature of alloy quenching. (auth)

33967 STRUCTURE OF MOLTEN MAGNESIUM–CADMIUM ALLOYS. Boos, Alfred; Steeb, Siegfried; Godel, Dieter (Max-Planck-Institut fuer Metallforschung, Stuttgart). Z. Naturforsch.; 27a: No. 2, 271-6(Feb 1972). (In German).

Alloys from the system Mg–Cd were investigated in transmission by x-ray diffraction. From the intensity curves radial atomic distribution functions were obtained which made it possible to determine the compound formation in the molten alloys of this system. The discussion of an additional intensity maximum yields the existence of the distance of 5.14 Å between two Cd-atoms in the melts with 10 to 60 at. % Cd. This distance is in agreement with a Cd–Cd-distance in the elementary cell of solid Mg_3Cd. Thus the existence of agglomerates of the composition Mg_3Cd_2 in these melts is demonstrated. It is pointed out that in this system (75 at. % Mg–25 at. % Cd) agglomerates exist in the melt which have the same atomic arrangement as the corresponding solid state although a temperature gap of more than 300°C separates the existence region of the solid state and the solidus. The results are confirmed by mass-spectrometric investigations which show that also the vapor phase of Mg_3Cd contains molecules of the composition Mg_3Cd_2. The importance of mass-spectrometric information for the confirmation of structural investigations of melts and amorphous solids is shown. (auth)

33968 SOLUBILITY OF HYDROGEN IN MOLYBDENUM. Oates, W. A. (Univ. of Newcastle, Australia); McLellan, Rex B. Scr. Met.; 6: No. 5, 349-52(May 1972).

Data are presented on the solubility of H in solid Mo in equilibrium with H_2 gas at 1 atm pressure and 905 to 1521°C. Measurements were made by hydrogenating Mo samples using pure H_2 in a quartz tube. Results are presented in tables and graphs. (J.R.D.)

Radiation Effects

Refer also to abstracts 33271, 33307, 35417, 35434, 35435, and 35438.

33969 (AERE-R-6298) INFLUENCE OF CRYSTAL PERFECTION AND IRRADIATION TEMPERATURE ON THE DAMAGE STRUCTURE AND ITS ANNEALING BEHAVIOUR IN NEUTRON IRRADIATED MOLYBDENUM. PART II. Eyre, B. L.; Maher, D. M.; Bartlett, A. F. (Atomic Energy Research Establishment, Harwell (England)). Jan 1970. 47p. Dep. NTIS (U. S. Sales Only).

Molybdenum, ranging in resistivity ratio ($\rho_{293°K}/\rho_{42°K}$) from 150 to 8000, was neutron-irradiated at 77 and 473°K to integrated fission neutron doses of $\sim 10^{20}$ cm^{-2} and $\sim 6 \times 10^{19}$ cm^{-2}, respectively. A detailed electron microscope study was made of the damage structures both before and after a post-irradiation anneal of one hour at 1173°K. It was found that the defect cluster topology in the irradiated specimens is a sensitive function of both material purity and irradiation temperature. A model is discussed specifically to explain the topology of interstitial clusters in which impurity assisted nucleation dominates. (auth)

33970 (BARC/I-131) IRRADIATION EMBRITTLEMENT OF REACTOR PRESSURE VESSEL STEELS. Sivaramakrishnan, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 14p. INIS.

Surveillance programs in reactors to evaluate changes in the properties of the respective steels used help in assessing and preventing any premature damage to pressure vessels. A brief survey was made of the literature published during the period 1966 to 1969 regarding the surveillance programs adopted in different countries both for existing and future reactors. Studies on evaluation of the degree of embrittlement that may be encountered in reactor pressure vessel steels (RPV-steels) during their lifetime inside the reactor are mentioned. Property changes on irradiation with special reference to Nil Ductility Temperature (NDT) are reported. Effects of interstitial elements like nitrogen, carbon, and hydrogen, effects of residual elements, effects of grain size and structure, and its sensitivity to irradiation induced embrittlement etc. are summarized. (INIS)

33971 (GEAP-13738) FAST NEUTRON DAMAGE IN TYPE-304 STAINLESS STEEL AND HIGH-NICKEL ALLOYS. Sandusky, D. W.; Ring, P. J.; Penrose, R. T. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Dec 1971. Contract AT(04-3)-189. 76p. Dep. NTIS.

A materials capsule containing Incoloy-800, Hastelloy-X, Inconel-625 tensile specimens, electron microscopy disks, and a Type 304 stainless steel supporting strip was irradiated in EBR-II to a peak fluence of 6.4×10^{22} n/cm^2 over a temperature range of 750 to 1275°F. No voids formed in the Type 304 stainless steel irradiated at temperatures greater than 1200 ± 25°F, but void size increased and number density decreased with increasing temperature of irradiation. No voids were found (zero swelling) in Inconel-625. Precipitation strengthened alloys had higher ultimate strength and 0.2% yield strength after irradiation. All high nickel alloys exhibited reduced ductility after irradiation. (auth)

33972 (HW-71451(Rev.)) IRRADIATION PERFORMANCE OF ZIRCALOY-2-CLAD URANIUM AND U-2 WT % Zr FUEL ELEMENTS, PRODUCTION TEST IP-309A (RM-576). Call, R. L.; Geering, G. T. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 23 Jul 1962. Contract AT(45-1)-1350. 36p. Dep. NTIS.

Declassified 2 Nov 1971.

Four 18-inch-long tubular fuel elements, three having natural uranium cores and one having a natural U–2 wt% Zr alloy core, were fabricated from coextruded Zircaloy-2-clad tube stock. The fuel element OD was 1.43 inch and the ID was 0.520 inch. Cladding thickness was 0.020 inch on both the inner and outer surfaces. The flush-fitting end closure rings were not bonded to the cores. The fuel elements were irradiated in high-temperature water until a failure terminated the test at an exposure of 1730 Mwd/ton. The failure occurred in the cladding at the end cap of one of the unalloyed pieces. The differential thermal expansion between cap and core and a contraction of the fuel adjacent to the cap introduced a ratcheting effect which caused the cladding to fail in shear. Incipient shear failures were found at the ends of three of the pieces irradiated in the test; the fourth piece was not examined. During irradiation, the fuel volume at the midlengths of the tubes increased 1.7 to 3.5%. (auth)

33973 EVOLUTION OF THE DIFFRACTION PATTERN OF AN ALUMINUM SAMPLE IRRADIATED WITH ELECTRONS FROM AN ELECTRON MICROSCOPE. Cordier, Alain; Degeilh, Andre (CNRS, Toulouse). J. Microscop.; 12: No. 2, 157-70 (Nov 1971). (In French).

The Kikuchi pattern of an aluminium sample was studied with the 300-kV electron microscope. An evolution of the lines was observed during the recovery period following electron beam irradiation (150 to 300 keV). The nature and concentration of the defects responsible for the evolution were deduced from these experiments. (France)

33974 EFFECTS OF NEUTRON IRRADIATION ON BULK AND MICRO FLOW-FRACTURE BEHAVIOURS OF PRESSURE VESSEL STEELS. Krafft, J. M.; Gray, R. A. (Naval Research Lab., Washington, D. C.). pp 93-102 of Practical Application of Fracture Mechanics to Pressure-Vessel Technology. London; Institution of Mechanical Engineers (1971).

From Conference on practical application of fracture mechanics to pressure-vessel technology; London, England (3 May 1971). See CONF-710534.

A new multi-specimen fatigue cracking machine was used to prepare some 200 K_{Ic} specimens for a detailed examination of the K_{Ic}(K) "rate spectrum" pattern of a mild steel at –140°C. More limited testing of "cold" as well as irradiated A533B steel indicated a similar pattern, but displaced in speed K in a way indicative of its higher quality (d_T), yet of its reduced ductility (ϵ_c) resulting from irradiation. Distinctive temperature-dependent variations in K_{Ic} were wholly unanticipated from bulk flow properties and the tensile instability model of K_{Ic}. However, such behavior is explicable if a pure matrix-iron composition of the fracture process zone d_T is assumed. This would also explain the full yield tearing energy. The use of "rate spectrum" matching for quality assessment of pressure vessel steels is suggested. (auth)

33975 MECHANICAL PROPERTIES OF LOW-TEMPERATURE-IRRADIATED MAGNESIUM. Pomar, C. (CNEA, Buenos Aires); Blewitt, T. H.; Bisogni, E. A. Phys. Status Solidi (a); 10: No. 2, 519-28(16 Apr 1972).

Magnesium crystals were irradiated at 77°K in the RA-1 reactor to neutron doses up to 4×10^{18} n/cm^2, and the deformation properties were studied at this temperature without warm-up. The yield stress increased with dose to a value of (465 ± 45) p/mm^2 at 1×10^{17} n/cm^2. For neutron doses greater than this value, the deformation mechanism changed with an upper yield point being formed with an accompanying yield drop. The upper yield point and yield drop increased with dose and became very substantial at 4×10^{18} n/cm^2 with the resolved yield stress increasing to 1000 p/mm^2 and the yield drop to the order of 50%. The lower yield stress was independent of dose in the higher dose region. Annealing experiments showed an annealing peak centered at 240°K. For large doses, recovery first occurred in the upper yield stress with the lower yield stress being unaffected until complete recovery of the upper yield stress occurred. Strain markings were studied and found inhomogeneous in character but different from a typical Lüders band. (auth)

33976 CHANGE IN STRUCTURAL PROPERTIES OF BISMUTH AND ITS ALLOYS BY IRRADIATION. Gumanskii, G. A.; Tashlykov, I. S. (Belrussian State Univ., Minsk). Inzh.-Fiz. Zh.; 21: No. 6, 1105-7(Dec 1971). (In Russian).

The effects of electron and proton irradiation on the structure of Bi and its alloys with lead were considered. The tested samples were irradiated by electrons with the energy of 6.8 MeV and integral dose of 7.4×10^{16} cm^{-2} and by protons with energy of 6.8 MeV and integral dose of 6.6×10^{14} cm^{-2}. Irradiation caused changes in the intensity of some diffraction lines in radiograms. An attempt is made to explain the effect observed. (auth)

33977 SIMPLE EXPLANATION FOR THE STABILITY OF VOIDS IN MATERIALS UNDER IRRADIATION. Brown, L. M. (McMaster Univ., Hamilton, Ont.). Scr. Met.; 6: No. 5, 387-93(May 1972).

A theory is proposed which supports the suggestion that an equilibrium array of voids are formed as a general consequence of irradiation at large enough doses to produce a steady state. The theory cannot be used to explain the body-centered lattice of voids but it can be used to predict the volume fraction of voids and void spacing. It can also be used to predict characteristic temperature and flux dependence of void spacing. (J.R.D.)

Other Materials

Refer also to abstracts 33148, 33965, 33977, 35276, 35427, and 35633.

33978 (LA-4896) CMB-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 18: Summary of Progress from May 1-July 31, 1971. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 22p. Dep. NTIS.

Research progress is reported on Santa Maria coke, highly oriented polycrystalline graphites, materials for ablation testing, raw materials, and the particle packing problem. (M.C.G.)

33979 (LA-4917) CMB-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 19, Summary of Progress, August 1-October 31, 1971. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 11p. Dep. NTIS.

Developments are reported for studies on: Santa Maria coke, including effects of grinding on crystalline parameters and resin-bonded graphites; raw materials, including Kynol fibers, properties and purities of coal-tar pitches, carbonization of resin components, and glass-like carbon filler; and hydrogen content of commercial cokes and graphites. (P.C.H.)

33980 STRUCTURAL BEHAVIOR OF METAL TRITIDE FILMS. Beavis, L. C.; Miglionico, C. J. (Sandia Labs., Albuquerque, N. Mex.). J. Less-Common Metals; 27: No. 2, 201-11 (May 1972).

Metal tritide films of five different elemental tritides have been observed over a five- to six-year period using interferometry and scanning electron microscopy. Initially the films exhibited a steady dilation with increasing age but no other effects. Later in life (after a few years) the films showed considerable spalling which was ascribed to the formation and rupture of bubbles. Tritides of any given element behaved in much the same manner, i.e., they showed total expansion and bubble formation and rupture at the same age. Tritides of the various elements behaved qualitatively in the same way, i.e., they exhibited bubble formation and expansion, but they differed noticeably in time with respect to apparent spalling, bubble density, bubble size and total expansion. A total film expansion of 10 to 20% was observed, bubbles varied from less than 1 to about 50 μm in linear dimension, and apparent spalling started from two to five years after the tritides were formed. (auth)

33981 CONCRETE-POLYMER MATERIALS PROGRAM. Steinberg, Meyer (Brookhaven National Lab., Upton, N. Y.). Isotop. Radiat. Technol.; 9: No. 3, 319-21(Spring 1972).

A summary is given of the tasks required for and the government agencies involved in the Concrete-Polymer Materials Program for developing and applying new and improved concrete materials of construction. (L.C.L.)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstracts 33229 and 33335.

33982 (IAEA-R-883-F) EXAMINATION OF POSSIBLE DESIGN CRITERIA WHICH WILL FACILITATE THE APPLICATION OF SAFEGUARDS. Final Report for the period, December 15, 1969—March 15, 1971. Hughes, H. A.; Allardice, R. H.; Brown, F.; Coles, R. F.; Ellingsen, J. E.; Goodwin, C. (International Atomic Energy Agency, Vienna (Austria)). Jun 1970. 17p. INIS.

The main areas of importance to safeguards have been identified and investigated. Of these areas the problems relating to reactor sites are straightforward and relatively easily dealt with. The primary requirement is for a system of bonded stores with fuel movement monitoring as a desirable back-up. Provided these requirements are met, continual inspection in a form enabling one inspector to deal with several reactors is possible. The problems of chemical plants are more difficult because of the multitude of process pipes involved and the varied nature of the material dealt with. Unlike a reactor, item handling is not possible. In dealing with conversion and fabrication plants the problems are eased since the composition of the input material can be identified without the difficulties of handling associated with active materials. The main area of difficulty is thus the reprocessing plant where the problems of dealing with a feed of somewhat indeterminate nature are compounded by the hazards of high activity. Moreover, the number of "effective kilograms" involved are such that the major safeguarding effort must be concentrated here. Consideration in detail of the reprocessing plant has shown that the achievement of accurate input data at the dissolver stage drastically reduces the need to fetter the remainder of the plant with its complex piping and control systems. Criteria have been suggested for the design of accountancy vessels which, if followed, should achieve the dual aim of reducing inspection effort for the remainder of the plant and thereby giving the plant operator greater freedom from control. The importance of the latter cannot be dismissed since the success of any safeguards system ultimately depends upon its acceptance at working levels. (INIS)

33983 SAFEGUARDS OF REACTOR MATERIALS. II. Zijp, Willem L. (Reactor Centrum Nederland, Petten). Atoomenergie Haar Toepass.; 14: 43-9(Feb 1972). (In Dutch).

A survey of the safeguards analysis and a description of work carried out in the Netherlands related to the Non Proliferation Treaty are presented. (auth) (Netherlands)

33984 RADIATION PROTECTION STANDARDS FOR THE LICENSING OF RELEASE OF RADIOACTIVE MATERIAL. III. Schwibach, J. Atomwirt., Atomtech.; 17: No. 5, 280-2(May 1972). (In German).

The release of radioactive material from nuclear installations will be licensed by agencies only when certain maximal limits are not exceeded. In addition to established limits, which mostly follow ICRP recommendations, the German Federal Republic uses standards in its licensing practice which are significantly lower. These standards, representing an additional safety factor for the population, are described in detail. (tr-auth)

Handling Equipment and Procedures

Refer also to abstracts 33228 and 33264.

33985 (JEN-228-DMe/I-24) CONSTRUCTION AND FINAL ASSEMBLY OF AN AUTOMATIC ARC WELDING MACHINE. Herrero Alvarez, J.; Diaz Diaz, J.; Diaz Diaz, J. L. (Junta de Energia Nuclear, Madrid (Spain)). 1972. 25p. (In Spanish). Dep. NTIS (U. S. Sales Only).

A remote arc welding machine was constructed which is wholly transistorized and designed to be used in a hot cell of 1.000 Ci. The equipment and its electronics are described. Final preparations such as ending of irradiation capsules, thermocouple welding, and stainless steel cover weldings are described. Procedures for these types of weldings are given. (auth)

33986 (RDT-E-8-6-T(3-72)) TRANSPORTER, FUEL HANDLING. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 31p. RSO.

A standard prescribing requirements for fuel transporter for nuclear and associated applications is presented. (J.R.D.)

33987 DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTES FROM PILOT PLANTS. Boback, M. W.; Davis, J. O.; Ross, K. N.; Stevenson, J. B. (National Lead Co., Cincinnati). Chem. Eng. Progr.; 67: No. 4, 81-6(Apr 1971).

The equipment and methods used for processing and disposing of low-level liquid wastes from the National Lead Company of Ohio pilot plant for producing U and Th materials are described. These procedures include daily sampling and analysis of the Th and U wastes to ensure that the river receiving the effluents maintains drinking-water quality standards. (L.C.L.)

33988 DEVICE FOR REPLACING USED GLOVES IN A GLOVE BOX. Clique, Alain-Marie (to Commissariat a l'Energie Atomique). British Patent 1,273,926. 10 May 1972. Priority date 4 Feb 1970, France.

A device is described for changing gloves in a double-walled glove box without interrupting either the impermeability of the box or the maintenance of subatmospheric pressure in the box. The device provides a means by which the new glove is immediately applied to the wall of the box thereby insuring impermeability so that the used glove can be removed. All handling of the used glove is done within the glove box which reduces the risk of contamination. (L.C.L.)

33989 APPARATUS FOR STORING AND EXPOSING A RADIOACTIVE SOURCE. Forrer, Gilbert R. (to Babcock and Wilcox Co.). U. S. Patent 3,655,983. 11 Apr 1972. Filed 24 Mar 1969.

A source exposing head is described which is adapted to be mounted on a container of radiation-resistant material which has a passageway within which a movable radioactive source is stored. The head is a mass of radiation-resistant material providing a shielded extension of the passageway of the storage container and provides an annularly shaped source exposure aperture externally of the storage container. (Official Gazette)

33990 RADIATION-SHIELDING RECEPTACLE FOR A BOTTLE FOR RECEIVING A RADIOACTIVE ELUATE. Brown, James L.; Himebaugh, Donald T.; Montgomery, James R. (to Mallinckrodt Chemical Works). U. S. Patent 3,655,985. 11 Apr 1972. Filed 20 May 1969.

A radiation-shielding receptacle for holding a glass bottle for receiving the eluate from the elution of a radioactive material is disclosed. The receptacle includes a hollow cylindric body of non-transparent radiation-shielding material having a window opening in its wall. A first end closure of radiation-shielding material is provided at one end of the body and a second end closure of radiation-shielding material is provided at the other end of the body. The second end closure has a central opening therein smaller than the internal diameter of the body and of a size so that the mouth of a bottle positioned in the body is exposed to receive the eluate. An insert of substantially transparent radiation-shielding material is secured in and fills the window opening so that the eluate in a bottle in the body may be viewed from the outside. The thickness of the body and the thickness of the insert are sufficient to provide a substantial amount of shielding against radioactive emission from the eluate. (Official Gazette)

Transportation

Refer also to abstract 33300.

33991 (UCRL-14903(Rev.2)) IMPROVED SHIPPING CONTAINER FOR FISSILE MATERIAL. Gaskill, James R.; Taylor, Robert D. (California Univ., Livermore. Lawrence Livermore Lab.). 3 Mar 1972. Contract W-7405-eng-48. 37p. Dep. NTIS.

Based on an ORNL design, an improved shipping container for fissile materials was developed. This container passed the normal and accident tests proposed in the current revision of AEC Safety Standards. Further, a criticality analysis by the LLL Criticality Safety Advisory Group established quantitative limits for shipping solid forms of enriched uranium and plutonium according to AEC criteria for Class I, Class II, and Class III categories. Tests made on simulated quantities of fissile material indicate the degree of internal heat buildup that can be expected in this container. (auth)

33992 IMPROVEMENTS TO PACKAGING FOR TRANSPORTING RADIOACTIVE OR SIMILAR MATERIALS. (to Robatel SLPI). French Patent 2,074,726. 8 Oct 1971. Filed 22 Jan 1970. (In French).

An improvement in the packaging of radioactive materials is described. A Pb shielding and a neutron shielding material are interposed between the inner vessel and the outer envelope. The neutron shielding material is placed inside tubular elements of high thermal conductivity metal and covered with Pb shielding. The cross section of the tubular elements is such that they form a continuous barrier with respect to the radial neutron passage. The elements are situated in two concentric rows, which are displaced from one another such that the elements of the first row occupy positions midway between those of the second row. Between the Pb shield and the outer envelope, an annular space is provided in which an anti-fire protective substance can be introduced. (France)

33993 EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR). REPORT I. Statens Offentliga Utredn.; No. 20, 1-61(1971). (In Swedish).

The work done by the investigating committee concerning carriage of dangerous goods by road is described. The proposal for a Swedish connection with the European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) of 1957 is given. A survey of present regulations, a description of the main content of ADR, and the future proposals for revision of ADR are presented. The text of the agreement and Swedish and English translations are given. (auth)

33994 EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR). SUPPLEMENT TO REPORT 1. Statens Offentliga Utredn.; No. 23, 1-162(1971). (In Swedish).

This index supplement to the report on the European Agreement Concerning the International Carriage of Dangerous Goods etc. (ADR), (Statens offentliga utredningar 1971: 20, 21 and 22) contains an alphabetical list of the dangerous goods discussed in supplement A and B, analytical tables of the contents in these supplements, and certain directions for determination of flash point. (auth)

33995 EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR). SUPPLEMENT B. REGULATIONS CONCERNING CARGO AND TRANSPORT VEHICLES. Statens Offentliga Utredn.; No. 22, 1-122(1971). (In Swedish).

Regulations for cargo and transport vehicles are given in this supplement to the European Agreement Concerning the International Carriage of Dangerous Goods by Road etc. (ADR). Radioactive goods are dealt with as well as explosive, inflammable, oxidizing, poisonous, and corrosive goods and those dangerous to health. (auth)

33996 EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS BY ROAD (ADR). SUPPLEMENT A. REGULATIONS CONCERNING DANGEROUS MATERIALS AND ARTICLES. Statens Offentliga Utredn.; No. 21, 1-248(1971). (In Swedish).

Regulations for dangerous materials and articles are given in this supplement to the European Agreement Concerning the International Carriage of Dangerous Goods by Road etc. (ADR). Radioactive, explosive, inflammable, oxidizing, corrosive, poisonous, and goods dangerous to the health are dealt with. (auth)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 34026 and 34919.

33997 (LBL–370) EXTERNAL BEAM OF THE BERKELEY 184-INCH SYNCHROCYCLOTRON. Paul, Arthur C. (California Univ., Berkeley. Lawrence Berkeley Lab.). 24 Nov 1971. Contract W-7405-eng-48. 41p. Dep. NTIS.

The experimentally determined external beam properties of the main beam and satellite beam of the Berkeley 184-inch synchrocyclotron are discussed and compared to a computer model based on elliptical phase space contours. Reasonable agreement is found for the profile of both beams and the relative centroid positions. The starting conditions of the beams are tabulated at several useful locations along the beam line. Comparison is also made to the phase space contours calculated from an extraction study based on the cyclotron's magnetic field and betatron oscillation amplitudes. (auth)

33998 (SLAC–139(Rev.)) DESCRIPTION AND PHYSICS PROGRAM OF THE PROPOSED RECIRCULATING LINEAR ACCELERATOR (RLA). (Stanford Linear Accelerator Center, Calif.). Feb 1972. Contract AT(04-3)-515. 78p. Dep. NTIS.

A method of approximately doubling the energy of the SLAC Accelerator by recirculation of the beam and reinjection into the machine for a second pass is described. The recirculator could also be used for high duty cycle (up to 6%) experiments at the recirculating energy by storing the beam and extracting about 1% of the electrons per revolution. Recirculation will initially occur at an energy of 17.5 GeV. Beam losses of ~125 MeV due to synchrotron radiation would be compensated by 2 sectors (666 ft) of standard accelerator sections operating at the accelerator frequency (2856 MHz). These sectors will be pulsed at a repetition rate of 43,500 pulses per second corresponding to the recirculating period of about 23 microseconds. The beam will be stored for 2.8 milliseconds (approximately 122 revolutions around the 6900 meter storage path); this is the time interval between the normal pulses of the accelerator. Using this method, the energy of the SLAC accelerator could be increased initially to about 42.5 GeV. The recirculator is designed to permit later increase of the storage energy to 25 GeV by the use of superconducting accelerator sections to restore the synchrotron energy loss. Then, assuming that a proposed program to replace the present 30 MW klystrons powering the accelerator with 60 MW models has been completed, the maximum beam energy would become 60 GeV. Upon completion of the proposed recirculation system the increased beam energy and duty cycle will greatly enhance its utility in particle physics research. A discussion of some of the physics opportunities which would become available is given. (auth)

33999 TRIUMF, 1971. Brearley, N. (Univ. of British Columbia, Vancouver). Phys. Can.; 28: No. 1, 12-14(1 Jan 1972).

TRIUMF is a meson facility currently under construction by a consortium comprising the three public universities of British Columbia plus the University of Alberta. The meson workshop is centered around a six-sector AVF cyclotron capable of accelerating H^- ions to a maximum energy of 500 MeV. Extracted proton beams will be variable in energy from 150 to 500 MeV. It will be possible to extract four beams simultaneously, but initially provision is being made for only two. Currently, the project as a whole is on schedule, and contracts have been placed for nearly all major items. TRIUMF is scheduled to produce its first beam towards the end of 1973. (Canada)

34000 SUPERCONDUCTING MICROTRON: ENERGY LIMITATIONS AND LOSSES. Alaux, Andre; Audet, Jean-Claude (Moncton Univ., New Brunswick, Can.). Can. J. Phys.; 50: No. 3, 298-300(1 Feb 1972). (In French).

Theoretical results were obtained using superconductivity to consider the operation of a microtron type accelerator. These results deal with the losses by Joules effect and with the energy limitations caused by the critical value of the magnetic field. The superconductive material considered is niobium and the operating temperatures are 4.2 and 1.85°K. (auth)

34001 METHOD OF AND APPARATUS FOR ACCELERATING PARTICLES. (to Cyclotron Corp.). British Patent 1,270,619. 12 Apr 1972. Priority date 20 Jan 1970, United States.

The combination of a cyclotron and a Van de Graaff accelerator for accelerating negative ions is described. The negative ions are first accelerated to about 15 MeV in the accelerator and then further accelerated in the Van de Graaff. The ion source and injection system and the beam extraction system are described. (W.H.K.)

34002 PROSPECTIVE DEVELOPMENT OF COLLECTIVE METHODS OF PARTICLE ACCELERATION. Vestn. Akad. Nauk SSSR; No. 11, 3-8(Nov 1971). (In Russian).

An approach to circumventing the present limitations of materials and techniques for producing high-frequency fields in accelerating systems lies in the so-called collective method of acceleration. Ring-shaped electron bunches (1967) and successful acceleration of 30-MeV α particles (1970) were milestones in this development trend. A modern 200-MeV collective accelerator uses a linear induction electron accelerator capable of accelerating 200 A of electron current to 1.5 MeV. The latter is injected into a chamber and forms a ring in which ions may be accelerated by means of a resonance system. Recent accomplishments by Sarantsev, Kolomenskii, Naumov, Markov, and others are summarized. (1 photograph) (K.S.W.)

34003 RETARDATION OF A RELATIVISTIC CHARGE NEAR AN IDEAL CONDUCTOR. Kuznetsov, A. B.; Rubin, S. B. (Joint Inst. for Nuclear Research, Dubna, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 9, 1466-70(Mar 1972).

Translated from Zh. Tekh. Fiz.; 41: No. 9, 1851-7(Sep 1971).

The interaction of a relativistic charge with an ideally conducting screen is studied for the case in which a charged filament moves near a half-plane. It is shown that the amplitude of the retarding force does not depend on the relativistic factor γ (for $\gamma \gg 1$); however, the effective range of the force is proportional to γ. The propagation of the total field into the shadow region is also analyzed. (auth)

34004 DISPERSION CHARACTERISTIC STUDIES FOR THE LINAC ACCELERATING STRUCTURE WITH STABILIZATION ARRANGEMENTS. Bomko, V. A.; Klyucharev, A. P.; Rudyak, B. I. (Physical-Technical Inst., Kharkov). Particle Accel.; 3: No. 2, 63-7(Apr 1972).

A new method is described for stabilization of field patterns in drift tube linear accelerators. The method involves the inclusion of radial posts located opposite to the drift tube stems and located at the nodes of modes adjacent to the operating mode. Results are presented of tests of the new method on three linear accelerators. (auth) (UK)

Auxiliaries and Components

Refer also to abstract 34396.

34005 (KFK–1468) IRRADIATION EFFECTS IN SUPERCONDUCTING SYNCHROTRON MAGNETS. Brechna, H.; Maurer, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Sep 1971. 30p. Dep. NTIS (U. S. Sales Only).

Synchrotron magnets placed at some distances downstream or upstream from septum magnets and targets are exposed to nuclear radiation. An estimate of the dose rate, pattern, and distribution of scattered particles and neutrons is presented. The effect of irradiation on superconducting composites, on matrix materials, on insulation, on magnet stability, and on increase in ohmic losses is given. The generation of defects and the effect on defect-clusters are calculated as functions of energy levels. Performance problems of superconducting magnets exposed to an irradiation environment are described. (auth)

34006 MEASUREMENT OF THE TRANSVERSE DIMENSIONS OF AN ELECTRON BEAM BY THE SYNCHROTRON-EMISSION METHOD OF A ROTATING DISC. Kozhevnikov, A. V.; Nikitin, M. M.; Medvedev, A. F. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 115-16(1971). (In Russian).

Radiation with an energy of 1.5 GeV from an electron synchrotron has been used to measure the lateral dimensions of an electron beam by several methods: the method of photographic filming speed, by electron-optical conversion, and by mechanical scanning with subsequent photoelectric conversion. The last method (rotating disc method) is described in some detail. The disc had a radius of 125 mm, and rotated at a speed of 3,000 rpm. The circumference was notched so that a time scan of the beam image was realized. An oscilloscope provided a visual picture of changes in electron density in the beam image, and from thence the radial dimensions of the beam were obtained. (K.S.W.)

34007 PRELIMINARY MEASUREMENTS ON A LOW PHASE VELOCITY SUPERCONDUCTING RESONANT CAVITY. Jones, C. M. (Oak Ridge National Lab., Tenn.); Judish, J. P.; King, R. F.; (and others). Particle Accel.; 3: No. 2, 103-13(Apr 1972).

Preliminary measurements are described on a low phase velocity, superconducting, helically loaded, lead plated resonant cavity operated in its fundamental mode at 136 MHz. The following approximate fields were obtained at a power consumption of 320 mW/m: maximum magnetic field 187 G, maximum electric field 4.75 MV/m, and axial accelerating field 0.7 MV/m. Axial electric field distributions in the fundamental and first two harmonic modes were measured. (auth) (UK)

34008 PULSED MAGNET POWER SUPPLY FOR FAST CYCLING SYNCHROTRONS. Marks, N. (Daresbury Nuclear Physics Lab., Eng.). Particle Accel.; 3: No. 2, 69-84(Apr 1972).

Some of the disadvantages of the magnet power supply system used to power present fast cycling synchrotrons are considered. The use of pulsed circuits on small synchrotrons is reviewed, and a current proposal to use a pulsed circuit in a larger machine is studied. A modified pulse circuit which overcomes many of the disadvantages of previous systems is then described and its operation explained. This system produces a superimposed third harmonic current component during acceleration and provides a flat top in the exclusively series connected magnet. An injection level bias current is also produced, there being no additional power sources required for this feature. The circuit is self-commutating, and is capable of discontinuous operation. Finally, the circuit is analysed and the effects of variation of component values are examined. (auth) (UK)

Ion Sources, Injection, and Extraction

34009 MECHANISM OF FORMATION OF UNSTEADY CURRENT IN A BETATRON. Sokolov, O. V.; Chastokolenko, B. L. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 83-90(1971). (In Russian).

For increasing the electron beam intensity in a betatron, the possibility of trapping the unstable current was considered. This problem is associated with the mechanism of formation of the unstable current, probably on the basis of resonant capture of electron oscillations by an inhomogeneity in the azimuthal distribution of the spatial change density produced by the electron beam from the injector. (tr-auth)

34010 PHOTOMETRIC STUDY OF THE IMAGE OF THE CROSS-OVER OF A POSITIVE hf ION SOURCE OPERATING WITH RARE GASES. Denizart, M.; Soum, G.; Degeilh, A.; Pilod, P. (Univ. Paul-Sabatier, Toulouse). Nucl. Instrum. Methods; 100: No. 2, 221-8(1972). (In French).

The photometric characteristics of the image of the cross-over of a hf source have been studied. After recalling the notions of emittance and brightness, the object (cross-over)—image correspondence in the accelerating tube is discussed. In the case of rare gases, the brightness of that image is measured after the optimum working conditions of the source have been determined. Results are in accordance with the theoretical interpretations for argon, krypton and zenon. (auth)

34011 HIGH POWER PENNING SOURCE FOR MULTIPLY CHARGED HEAVY IONS. Bennett, J. R. J. (Stanford Univ., Calif.); Gavin, Basil. Particle Accel.; 3: No. 85-91(Apr 1972).

The performance of a continuously operated PIG source for multiply charged heavy ions is described. The source was initially designed with large cathodes to operate in a nonuniform magnetic field to increase the power dissipation but the output of highly charged ions was disappointing. Operation of the source in a uniform field produced large fractions of the ion current in the high charge states. Changes to the anode resulted in further improvement. Nitrogen and argon gases were used in the experiments and the best percentages of ion currents in the higher charge states were 1.5 percent of A^{8+}, 0.3 percent of A^{9+} and 0.8 percent of N^{5+}. Xenon was also tried, but confusion of the charge states higher than Xe^{9+} with argon contamination prevented analysis of the spectrum. Finally water-cooled cathodes were used, but the gas flow had to be relatively high to maintain the discharge and the yield of the high charge state ions was poor. (auth) (UK)

34012 RF REGULATOR FOR SATURNE'S INJECTOR. Sitbon, V. Particle Accel.; 3: No. 2, 115-25(Apr 1972). (In French).

In 1969, Saturne synchrotron's Van de Graaff injector was replaced by a 20-MeV proton linac. During normal operation, the required current is greater than 20 mA. A beam-loading compensation being necessary, especially because of the 600 μsec pulse length, it was decided to study the real rf field build-up in the cavity; a dynamic measurement of the driving loop input impedance was undertaken, a feedback circuit was then constructed, which is now operating on the 20-MeV linac; its design and performance as well as the preliminary studies are described. (auth) (UK)

Ion Optics and Field Calculations

Refer also to abstract 34553.

34013 (INSJ-133) MAGNETIC FIELD MEASUREMENTS OF THE 107 CM MODEL MAGNET FOR THE 176 CM SF CYCLOTRON. Tanabe, Tetsumi; Ogawa, Hirotsugu; Sakurada, Yuzo; Furuya, Motokazu; Yamazaki, Tsutomu; Hirao, Yasuo (Tokyo Univ. (Japan). Inst. for Nuclear Study). 23 Mar 1972. 50p. Dep. NTIS (U. S. Sales Only).

A 107-cm model magnet system for the design of a 176-cm variable-energy sector-focused cyclotron is described. The measuring procedures and data processing are described. Results of main coil measurements, trim coil measurements, valley coil measurements, and measurements of first and second harmonic components are present and discussed. Also, results of calculations of the isochronous fields and focusing properties are given. (W.H.K.)

34014 (UCRL-Trans-1470) BEAM FOCUSING IN THE ELECTRON GUIDE OF A COLLECTIVE-ACCELERATOR MODEL. Belyaev, A. P.; Ryl'tsev, P. I. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from report JINR-P9-6081. 34p. Dep. NTIS.

Calculations are reported on the focusing system of the electron guide of a collective accelerator model designed for electron beam transport at a beam current of 50 to 150 A, energy of 1.5 to 2.5 MeV, and emittance of 20 to 100 mrad · cm. Focusing is achieved with the aid of magnetic lenses. Graphs of beam envelopes in the drift gaps are given, together with the magnetic fields on the guide axis and the disposition of the focusing lenses under various accelerator operating conditions of the accelerator. (auth)

34015 STABILITY OF FOCUSED AZIMUTHALLY HOMOGENEOUS ELECTRON BEAM. Grigor'ev, V. P.; Didenko, A. N. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 32-7(1971). (In Russian).

Using the method of a self-consistent field, the stability of a focused azimuthally-uniform beam of electrons moving in a cylindrical resonator located in a focusing magnetic field is calculated. Dispersion equations are derived, the harmonics of possible oscillations are determined, and the increments of resonance instability are found. (tr-auth)

34016 STATIONARY DISTRIBUTION IN LONGITUDINAL UNIFORM MAGNETIC FIELDS. Tanguy, P.; Roux, C. (Univ., Rennes, France). Nucl. Instrum. Methods; 100: No. 2, 365-9 (1972). (In French).

The modifications which occur in the phase space distribution of a beam of charged particles when one takes into account solenoidal fringing fields are studied. It is shown that in a longitudinal magnetic field following the fringing geometry, stationary distributions can be obtained. A method is given to calculate these distributions. (auth)

Storage Rings

Refer also to abstract 34561.

34017 (NP-tr-1937) ELECTRODYNAMIC INTERACTION OF PARTICLES ON THE LONGITUDINAL DIMENSIONS OF ELECTRON PACKETS IN A STORAGE RING. Grigor'ev, Yu. N.; Grichaev, I. A.; (and others). (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated by H. Polge (CEA, Saclay, France), from report KHFTI-71-33. 15p. (In French). Dep. NTIS (U. S. Sales Only).

Electrodynamic interaction forces of electrons are studied taking into account the shielding effect of the metallic vacuum chamber on the phase motion of electrons in the storage ring. For small phase oscillations, assuming that the distribution of electrons in the beam of the storage ring is quasi-stationary, the decrease of synchrotron oscillations is calculated theoretically taking into account the electrodynamic interaction forces of the electrons. It is shown that with the increase in number of the stored particles, the decrease of synchrotron oscillations of the isolated particle diminishes, which leads as a result of the quantum fluctuations of the radiation to the increase of the longitudinal dimensions of the bunch in the storage ring. It is shown that the increase of longitudinal dimensions of the bunch in the storage ring of 100-MeV electrons can be explained by the operation of two factors: the electron electrodynamics interaction, which is studied, and the Touschek multiple effect. (J.F.P.)

Experimental Facilities

34018 (LBL–755) TARGET HANDLING DEVICE FOR TIME-OF-FLIGHT APPARATUS. Babin, Alexander (California Univ., Berkeley. Lawrence Berkeley Lab.). Mar 1972. Contract W-7405-eng-48. 21p. Dep. NTIS.

A mechanical device is described for holding and inserting a target foil and its protective cover into the beam line of a linear accelerator. The method of operation is graphically demonstrated. (auth)

34019 (NP–19321) HF-MEASUREMENTS ON A SUPERCONDUCTING Nb-DEFLECTOR. Dammertz, G.; Dittmann, R.; Hahn, H.; Votruba, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). May 1971. 25p. (In German). Dep. NTIS (U. S. Sales Only).

The application of superconducting cavities to linear accelerators and RF beam separators requires high quality factors as well as high field levels. The obtainable values are dependent on the treatment of the surfaces. After chemical polishing and firing in a vacuum furnace, a quality factor $Q_0 \simeq 2.10^9$ and a magnetic field level $H_p \simeq 220$ G were reached in a deflecting structure operating in the π/2-mode at S-band. Despite the high quality factor a dependence on the field configuration was observed. The field limitation was caused by magnetic breakdown. Other limitations due to thermal effects and multipactoring also occurred. (auth)

34020 NEUTRON PRODUCTION FROM HYDROGEN ISOTOPES. Batra, G. J.; Bewley, D. K.; Chaudhri, M. A. (Hammersmith Hospital, London). Nucl. Instrum. Methods; 100: No. 1, 135-9(1972).

Deuterium and tritium gas targets are investigated as a possible alternative to a beryllium target for the production of fast neutrons for therapy and activation analysis. Thick target yields and spectra for incident deuteron energies up to 16 MeV are calculated for both the (d,n) and (d,np) reactions. The theoretical results are supplemented by experimental measurements of dose rate and neutron spectra which are in good agreement with the theory. (auth)

34021 PRODUCTION OF INTENSE MONOCHROMATIC X RAYS. Chartier, J. L. (CEN, Fontenay-aux-Roses, France); Portal, G.; Roman, D.; Duguay, D. Nucl. Instrum. Methods; 100: No. 1, 107-19(1972). (In French).

This study reports on the results of research carried out within the framework of a contract concluded between the Commission of the European Communities and the Commissariat à l'Énergie Atomique in 1970. The phenomenon of fluorescence was used for the production of monochromatic X-rays. The influence of various parameters on the purity of the radiation and intensity obtained was studied by means of an experimental device. This made it possible to design a simple installation which enabled beams to be obtained up to 100 keV from X-rays which were practically monoenergetic, the intensity of which was comparable with and often greater than that of beams "hardened" by filtration. (auth)

34022 ASSOCIATED PARTICLE NEUTRON TIME OF FLIGHT SYSTEM. Johnson, P. B.; Callaghan, J. E.; Bartle, C. M.; Chapman, N. G. (Victoria Univ., Wellington, N. Z.). Nucl. Instrum. Methods; 100: No. 1, 141-8(1972).

A fast ^{3}He–n timing system having significantly improved timing resolution has been developed for the D(d,n)^{3}He reaction at incident deuteron energies below 400 keV. The associated particle technique is used to define a neutron beam at an angle in the laboratory between 40° and 120°, determined by the angle at which the associated ^{3}He particles are detected. Unambiguous ^{3}He particle detection, resulting from the use of a magnetic analyzer to shield the surface barrier ^{3}He particle detector from scattered deuterons, allows the absolute neutron flux in the associated neutron beam to be precisely determined. The derivation of a fast timing signal from the detector voltage pulse enables a constant fraction pulse height discriminator to be triggered on ^{3}He pulses of equivalent energy less than 500 keV without spurious triggering on noise. The ^{3}He–n timing resolution obtained after compensation for the energy dependent ^{3}He flight times is 2.8 ns (fwhm) in the particular case of a 2.40 MeV neutron beam defined at 102°, and 3.2 ns (fwhm) in the case of a 2.80 MeV neutron beam at 50°. The effect of instrumental timing jitter and walk in the system is virtually negligible. Stable neutron beams having intensities of over 120 neutrons $\sec^{-1}$msterad^{-1} averaged over the beam profile are maintained for long periods. The random background count rates outside the neutron beam typically correspond to a neutron flux of less than 2×10^{-5} that of the direct beam. (auth)

34023 STABILISED POWER SUPPLIES AT THE RUTHERFORD LABORATORY. Culliford, D. R. (Rutherford High Energy Lab., Chilton, Eng.). Electron. Power; 18: 133-5(Apr 1972).

In the 7 GeV accelerator, Nimrod, magnetic elements are used to direct the beams of charged particles onto their experimental targets. The magnetic fields of the two types of elements used (quadrupole and bending magnet) must be held constant and are controlled by highly stabilized power supplies. Magnet load details and the power supplies in use in the laboratory are tabulated. The two types of power supplies used (transducer units and thyristor units) are discussed, and operational experience with them given. (UK)

34024 EXPERIMENTAL SETUP FOR DOUBLE- AND SINGLE-SCATTERING EXPERIMENTS AT MEDIUM ENERGIES. Seibt, E.; Weddigen, CH. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods; 100: No. 2, 253-66(1972). (In German).

An experimental set-up is described for double and single scattering experiments which has been installed at the Karlsruhe isochronous cyclotron (52 MeV deuterons and 104 MeV α-particles). Primary and secondary scattering angles can be easily changed during an experiment. A quadrupole triplet serves to collect the particles from the first to the second target. A special monitor system for the secondary beam allows effective alignments within ±0.02°. Pure semiconductor and combined semiconductor scintillation telescopes allow for particle identification. The primary energy can be varied by water cooled absorbers. The apparatus has been used for differential cross section and polarization measurements involving spin 0-, ½- and 1-particles. (auth)

34025 CONSIDERATIONS FOR EXTERNAL TARGETS IN AN INTENSE INTERMEDIATE ENERGY PROTON BEAM. Wynchank, S. (Brooklyn Coll.). Nucl. Instrum. Methods; 100: No. 2, 361-4(1972).

Problems of shielding requirements and of minimization of induced activity are considered for external Be targets in a proton beam of intensity 50 μA and energy about 600 MeV. (auth)

34026 USE OF MIST PARTICLES AS TARGETS AND FOR ACCELERATION. Katsaurov, L. N. Kratk. Soobshch. Fiz.; No. 10, 56-63(Oct 1971). (In Russian).

The possibility of using mist particles as a jet target was studied since they may be electrically charged and focused by a magnetic or electric field. The evaporation resulting from encounter by an accelerated beam is an important factor, especially if the velocity of the target particle is small. Acceleration of a mist particle is dependent on the particle radius and a significantly smaller numerical value of the accelerating potential. However, realization of currents in a pulse in hundreds or even millions of amperes is theoretically possible, but it is very difficult to attain the requisite energies in a particle of such dimensions. (K.S.W.)

34027 ANGULAR DEPENDENCE OF DOSE AND HADRON YIELDS FROM TARGETS IN 8 GeV/c AND 24 GeV/c EXTRACTED PROTON BEAMS. Levine, G. S. (Rutherford High Energy Lab., Chilton, Eng.); Squier, Dorothea M.; Stapleton, G. B.; (and others). Particle Accel.; 3: No. 2, 91-101(Apr 1972).

Measurements using standard activation and dosimetric techniques of the angular variation of hadron flux density and absorbed dose around targets in extracted proton beams at lab angles between 2° and 170° show good agreement with the predictions of Monte Carlo calculations based on a modified Trilling formula over the angular range 5 to 30°. The dependence of the yield on target material was studied using targets of aluminium, copper and tungsten alloy. At wide angles the measured fluences (or dose) per proton interacting in a copper target rise less rapidly than the hadron multiplicity as the incident proton energy increases. The application of these results to the prediction of dose and induced activity levels in extracted proton beam target stations is discussed. (auth) (UK)

34028 METHOD AND DEVICE FOR MODULATING OR STABILIZING A NEUTRON FLUX OBTAINED FROM AN ION

ACCELERATOR. Pierson, Alexandre (to Commissariat a l'Energie Atomique). U. S. Patent 3,657,539. 18 Apr 1972. Priority date 28 Jun 1969, France.

A method and device for modulating or stabilizing a neutron flux obtained by bombarding a suitably charged target with nuclear particles which are produced in a pulsed form is described. The pulsation frequency of the particle source is modulated or stabilized and the duration of the pulsations of said source is controlled in dependence on the measurement of the neutron production rate of the target. (auth)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

Cosmic Radiation

Refer also to abstracts 33482, 34236, 34238, 34242, and 34556.

34029 (NP-19229) COMPENDIUM OF COSMIC PHYSICS. Compendium No. 5. Amundsen, R. (Bergen Univ. (Norway). Dept. of Physics). Nov 1970. 145p. (In Norwegian). Dep. NTIS (U. S. Sales Only).

Topics discussed include the following: composition of cosmic radiation, energy content and distribution, origin and extent of radiation, some acceleration processes, variations in radiation intensity, cosmic radiation and the Earth's magnetic field, meteorological effects on radiation intensity, the solar wind and the interplanetary field, Forbush decreases, long-term variations, 27-day variations, daily variations, annual variations, solar-flare effects, Boltzmann's equation and its application to modulation of galactic cosmic radiation, and the Fokker–Planck equation and its application to solar-flare effects and to radiation belts around the Earth. (A.G.W.)

34030 NEURON-CAPTURE EFFECTS IN LUNAR GADOLINIUM AND THE IRRADIATION HISTORIES OF SOME LUNAR ROCKS. Lugmair, G. W.; Marti, K. (Univ. of California, San Diego, La Jolla). Earth Planet. Sci. Lett.; 13: No. 1, 32-42(Dec 1971).

The Gd isotopic composition in 19 lunar rock and soil samples from three Apollo sites is reported. The analytical techniques and the high precision mass spectrometric measurements are discussed. Enrichments in $^{158}GdO/^{157}GdO$ due to neutron capture range up to 0.75%. Integrated "thermal" neutron fluxes derived from the isotopic anomalies of Gd are compared with spallation Kr data from aliquot samples to construct a model which gives both average cosmic-ray irradiation depths and effective neutron exposure ages (T_n) for some rocks. In the case of rock 12053, this yields an average sample location of ~300 g/cm² below the lunar surface and an effective irradiation age of ~230 my, compared to 99 my obtained by the $^{81}Kr-Kr$ method. Rock 14310 is the first lunar sample where Kr anomalies due to resonance neutron capture in Br are observed. A $^{81}Kr-Kr$ exposure age of 262 ± 7 my is calculated for this rock. (auth)

34031 NEUTRON CAPTURE ON ^{149}Sm IN LUNAR SAMPLES. Russ III, G. P.; Burnett, D. S.; Lingenfelter, R. E.; Wasserburg, G. J. (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 13: No. 1, 53-60(Dec 1971).

High-precision isotopic composition measurements of Sm were carried out for two terrestrial and seven lunar samples from three Apollo sites. The lunar samples, selected to show a wide variation in cosmic-ray exposure ages, had a wide range of enrichments in $^{150}Sm/^{154}Sm$ (up to 0.8%) and depletions in $^{149}Sm/^{154}Sm$ due to neutron capture. The ratio of the number of neutrons captured per atom by ^{149}Sm to ^{157}Gd was 0.9 and reflects a hardened lunar neutron spectrum. This ratio was in reasonable but not exact agreement with that obtained from the theoretical lunar neutron energy spectrum of Lingenfelter, Canfield, and Hampel. The average composition for terrestrial samarium was $^{144}Sm : ^{147}Sm : ^{148}Sm : ^{149}Sm : ^{150}Sm : ^{152}Sm : ^{154}Sm = 3.074 : 14.995 : 11.243 : 13.820 : 7.380 : 26.739 : 22.749\%$. (auth)

34032 AGE OF AN APOLLO 15 MARE BASALT: LUNAR CRUST AND MANTLE EVOLUTION. Wasserburg, G. J.; Papanastassiou (California Inst. of Tech., Pasadena). Earth Planet. Sci. Lett.; 13: No. 1, 97-104(Dec 1971).

An internal Rb–Sr isochron for the large basalt boulder 15555 returned from the edge of Hadley rille by the Apollo 15 mission yields an age 3.32 ± 0.06 AE and an initial $^{88}Sr/^{86}Sr$, I = 0.69934 + 5. This age and I value fall well within the range obtained for the Apollo 12 basalts from the Ocean of Storms and may indicate that extensive lava flows occurred at ~3.3 AE over widespread areas of the Moon. The Sr composition of the anorthosite 15415 is as low as that of plagioclase extracted from the Apollo 11 low K rocks. The initial Sr composition of 15415 for an assumed age of 3.3 to 4.6 AE is extremely primitive and provides further evidence for an extremely short formation interval (3 to 1 × 10^6 yr) of a nonchondritic Moon with respect to an origin in time defined by BABI. The initial $^{87}Sr/^{86}Sr$ for crystalline rocks returned from all lunar missions is correlated with the concentration of Rb and correspondingly K, U, and Th. This correlation places distinctive constraints on the evolution of lunar magmas and the internal structure of the Moon. (auth)

34033 LUNAR BASALT GENESIS: THE ORIGIN OF THE EUROPIUM ANOMALY. Graham, A. L.; Ringwood, A. E. (Australian National Univ., Canberra). Earth Planet. Sci. Lett.; 13: No. 1, 105-15(Dec 1971).

The trace-element abundances of lunar basalts are examined, and the implications of the near-chondritic relative abundances of incompatible elements are discussed. It is inferred that in the source regions of lunar basalts the incompatible elements, e.g., Ba, U, and RE^{3+}, are residing in accessory minerals that enter the first liquid quantitatively during the earliest stage of partial melting. On the other hand, the abundance relationships of europium in lunar basalts imply that it is present in different phases, and probably occurs as a compatible or dispersed element within principal silicate mineral(s) of the source region. It is shown that with this distribution of trace elements in the source region, and under appropriate conditions of partial melting, most of the europium may be retained within the principal host mineral(s) in the source region, and the observed trace element abundance patterns in lunar basalts, including the europium anomaly, may thereby be explained. Specifically, it is demonstrated that the observed abundance patterns are consistent with varying degrees of single-stage partial melting of a pyroxenite source material possessing near-chondritic absolute abundances of incompatible trace elements. Relations between partial melting processes in the Earth's mantle and the lunar interior are discussed. The model of partial melting developed herein provides a possible explanation for the observed Rb/Sr whole rock ages of the mare basalts and for the highly radiogenic strontium often observed in terrestrial alpine ultramafic rocks. (auth)

34034 Rb–Sr AGES ON DENSITY AND SIZE FRACTIONS OF APOLLO 11 FINE SOIL SAMPLE 1084. Pinson, W. H. Jr.; Hurley, P. M. (Massachusetts Inst. of Tech., Cambridge). Earth Planet. Sci. Lett.; 13: No. 1, 130-3(Dec 1971).

Size and density fractions of Apollo 11 soil show that the materials <60 μm and <3.0 g/cm³ have $^{87}Rb/^{86}Sr$ and $^{87}Sr/^{86}Sr$ values that are closer to a 4.6 AE model isochron than coarser and more dense fractions. The latter increasingly approach a mixing line between high-K and low-K Apollo 11 basalts, or their mineral constituents. None of the fractions exceeds a model age of 4.6 AE. A material balance agrees with the total soil analyses. The results support the conclusion that the allochthonous part of the aggregate came in as impact ejecta from source materials that differentiated early in lunar history and were not subsequently modified in Rb/Sr ratio during a remelting or impact event. A clustering of values for the more allochthonous material suggests that it comes from a surrounding region in which the average values are: Rb ≃ 2.9 ppm, Sr ≃ 185 ppm and $^{87}Sr/^{86}Sr \simeq 0.7019$. (auth)

34035 EXTRAGALACTIC COSMIC RAYS AND THE PRODUCTION OF LIGHT ELEMENTS. de Freitas Pacheco, J. A. (Univ., Sao Paulo, Brazil). Astron. Astrophys.; 18: No. 3, 450-2(May 1972).

It is shown that the galactic diffusion coefficient D calculated previously (Pacheco, 1971) for relativistic cosmic rays remains basically unchanged irrespective of whether the primaries are of galactic or extragalactic origin. (auth)

34036 EXTREME ISOTOPIC COMPOSITIONS OF CARBON AND REDOX PROCESSES. Javoy, M. (Faculte des Sciences, Paris). Nature (London) Phys. Sci.; 236: No. 65, 63(27 Mar 1972).

It is stated that carbonate phases highly enriched in ^{13}C have been found in carbonaceous chondrites; in some cases the enrichment has ranged from 40 to 70% compared with the PDB standard. An enrichment of 25% in ^{13}C was also reported for the carbonate phase of a kimberlitic dike. Explanations put forward have not been entirely satisfactory; the present communication attempts to show that high enrichments can be accounted for by Rayleigh distillation involving oxidized and reduced forms of C. A decrease in temperature in the presence of mineral assemblages caused the transformation of CO_2, stable at high temperatures, to reduced forms of carbon such as CH_4. Also, large equilibrium fractionations can occur, even at high temperatures, between oxidized and reduced forms of C, and this would make it possible to produce large fractionations by means of a Rayleigh process. For carbonaceous chondrites the oxidized form is trapped as carbonate and the reduced form consists chiefly of an "aromatic polymer," and if it is assumed that the CH_4 was formed initially during the reduction process and then trapped as the aromatic compound, temperatures for the redox process may be calculated, giving 325°C for type I chondrites and 450°C for type II. (UK)

34037 COSMIC-RAY DENSITY DISTRIBUTION NORMAL TO THE SOLAR EQUATORIAL PLANE AND THE SEMI-DIURNAL ANISOTROPY. Pathak, P. N. (Physical Research Lab., Ahmedabad, India). Planet. Space Sci.; 20: No. 4, 533-47(Apr 1972).

Distributions of galactic cosmic-ray density normal to the solar equatorial plane are derived by two different methods and the resulting semidiurnal anisotropy is studied in detail. In the first method, it is assumed that cosmic-ray intensity at any heliolatitude θ is inversely proportional to the solar coronal intensity (λ5303) at the same heliolatitude. The second method is based on Parker's model of the anisotropic diffusion of cosmic rays, in which the size of the modulating region (R) and the parallel diffusion coefficient ($K_{||}$) are assumed to be independent of heliolatitude while the solar-wind velocity (V) is assumed to be a function of heliolatitude through an empirical relationship connecting λ5303 intensity and solar-wind velocity observed on Mariner-2 and IMP-1 spacecrafts. Following the method suggested by Subramanian and Sarabhai (1967), the semidiurnal anisotropy arising from these distributions is estimated for neutron monitors situated at Deep River and Huancayo. It is found that both methods give semidiurnal amplitude with a rigidity dependence given by P^β where P is the rigidity and β is positive in agreement with the observations. The phase of the semidiurnal anisotropy obtained by the first method is found to be generally along the direction of the interplanetary magnetic field while that obtained by the second method is nearly perpendicular to the direction of the interplanetary magnetic field in agreement with the experimental observations. In view of the recent observations regarding the absence of long-term variations in V and $K_{||}$ (Mathews et al., 1971), it is shown that a small change in R (~2 AU) over a solar cycle can produce the required long-term modulation of galactic cosmic-ray intensity when V and $K_{||}$ are constant. (auth)

34038 UPPER LIMIT OF CONTENT OF ANTINUCLEI IN PRIMARY COSMIC RAYS. Ivanova, N. S.; Kulikov, V. N.; Yakubovskii, E. A. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 15: No. 5, 182-3 (5 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 5, 261-5(5 Mar 1972).

Data taken on the Kosmos and Soyuz satellites and interplanetary Zond stations are compared with earlier measurements of antinuclei content in primary cosmic radiation. It is shown that the accuracy of these measurements greatly exceeds all previous ones. (M.O.W.)

34039 IONOSPHERIC CONFIRMATION OF MODULATION PROCESSES IN PLASMA AROUND THE EARTH. Nestorov, G. T. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 10, 1317-20(1971).

Observations at Sofia of ionospheric absorption at 26 kHz over a 12-year period have supplied ample material revealing the nature and behavior of the lowest part of the ionosphere over a period exceeding a complete solar cycle. Variations in the ionospheric absorption (modulation processes) are examined. (W.D.M.)

34040 CALCULATION OF THE MUON STOPPING RATIO UNDERGROUND FROM THE SURFACE SPECTRUM. Benbrook, J. R. (Univ. of Houston, Tex.); Bazer-Bachi, A. R.; Kern, J. W.; (and others). Lett. Nuovo Cim.; 3: No. 13, 557-61(25 Mar 1972).

It is of interest to be able to relate the stopping muons underground to the muon spectrum at the surface since the surface muon spectrum can be experimentally determined independent of the depth-intensity curve. The ratio R was calculated from the surface muon energy spectrum via the muon range–energy relation to verify the agreement between magnetic spectrometer data and atmospheric high-energy gamma spectrum. (W.D.M.)

34041 INFLUENCE OF THE IONIZED MEDIUM ON SYNCHROTRON EMISSION IN INTERSTELLAR SPACE. Ramaty, Reuven (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 174: No. 1, 157-63(15 May 1972).

The effect of the inoized gas on synchrotron emission in the interstellar medium was investigated. A detailed calculation of the synchrotron emissivity of cosmic electrons, assumed to have an isotropic pitch-angle distribution in a uniform magnetic field, was made as a function of frequency and observation angle with respect to the field. The results are presented both as a local emissivity and as an intensity, the latter obtained by neglecting free–free absorption in the interstellar medium and by assuming that the emissivity is constant along the line of sight. The comparison of the results with previous studies on the nature of the low-frequency turnover of the galactic nonthermal radio background reveals that, except if the component perpendicular to the line of sight of the interstellar magnetic field is small (less than ~1 microgauss), or if the cosmic-ray electron spectrum is cut off at energies below a few hundred MeV, the suppression of synchrotron emission by the ambient electrons has in general a lesser effect than free–free absorption by these electrons, and that in some cases ($B_\perp \sim 5$ microgauss, $n_e < 0.03$, and no low-energy cutoff) this suppression effect is almost entirely negligible. (auth)

34042 MEASUREMENT OF THE SECONDARY GAMMA SPECTRUM FROM 0.2 TO 5 GeV IN THE LOWER ATMOSPHERIC LAYERS. Koehn, Diederich; Mueller-Glewe, Juergen (Christian-Albrechts-Univ., Kiel). Atomkernenergie; 19: No. 2, 157-60(Apr 1972). (In German).

Measurements with a γ spectrometer in the energy range 0.2 to 5 GeV are reported which were obtained at sea level and in the atmosphere up to 16 km height. The photon energy was deduced from the electromagnetic cascades created in a lead-scintillator sandwich. The exponent of the integral spectrum $I_\gamma(E_\gamma) \propto E_\gamma^{-n}$ remained constant n = 1.85 throughout the whole height range for $E_\gamma > 1$ GeV and the absorption length of 170 g/cm^2 for $E_\gamma \geq 200$ MeV did not vary below the transition maximum. A comparison with the results of other authors shows that over a wide range of energies the absorption length does not depend upon the energy of the photons. (auth)

34043 UHF RADIO PULSES ASSOCIATED WITH OPTICAL CHERENKOV EMISSION FROM EXTENSIVE AIR SHOWERS AT THE ZENITH. Fegan, D. J. (University Coll., Dublin). Lett. Nuovo Cim.; 3: No. 18, 715-19(29 Apr 1972).

In a previous experiment (Fegan and Jennings, 1969), using a threefold scintillation-counter trigger system in conjunction with a uhf receiver, a significant number of particle–radio coincidences were found at a trigger threshold energy of 2×10^{15} eV. In this present experiment the scintillation counters were dispensed with and an optical Cherenkov receiver was used as a trigger source. It was concluded that the lateral distribution of the radio pool is much less in the uhf band than at frequencies below 100 mHz. (W.D.M.)

34044 PROCEEDINGS OF THE 11th INTERNATIONAL CONFERENCE ON COSMIC RAYS. VOLUME 2. SOLAR COSMIC RAYS: MODULATION OF GALACTIC RADIATION AND MAGNETOSPHERIC AND ATMOSPHERIC EFFECTS. Conference Held at Budapest, August 25—September 4, 1969. Somogyi, A. (ed.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 1-767(1970). (CONF-690814—(Vol.2)).

Separate abstracts were prepared for 120 of the 123 papers presented. Three papers appeared previously in NSA. Abstracts for Volumes 3 and 4 of the conference proceedings will be included in subsequent issues of NSA. (W.D.M.)

For abstracts of individual papers see: 34045–34136, and 34235–34262.

34045 NONLINEAR INTERACTION OF GALACTIC COSMIC RAYS WITH SOLAR WIND. Dorman, I. V.; Dorman, L. I. (IZMIRAN, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 17-20(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

It is shown that if the dimensions of the solar wind (taking into account supersonic and subsonic regions) are large (not smaller than a few AU), then in the investigation of cosmic-ray modulation effects and dynamical processes in interplanetary space at large distances from the Sun it is necessary to take into account the phenomenon of autofocusing of the solar-wind streams by cosmic rays. This phenomenon is as follows: if a solar wind sector has more intense modulating properties than the surrounding region (say, in this sector the radial velocity of plasma is higher or the transport path for particle scattering is smaller) then a relative decrease of cosmic-ray intensity will occur in this sector. The consequent transverse gradient of cosmic-ray density causes these sectors to become compressed by cosmic-ray pressure, which leads to stronger modulating properties. Therefore, it is believed that with an increase in the distance from the Sun there must be an increase in the nonuniformity of the solar wind. In particular, this phenomenon must lead to an increase of the concentration of solar wind in heliolatitude zones with maximum solar activity. (auth)

34046 SOME MODELS OF SOLAR WIND INFLUENCE ON GALACTIC COSMIC RAYS TO THE APPROXIMATION OF ANISOTROPIC DIFFUSION. Belov, A. V.; Dorman, L. I.; Shakhov, B. A. (IZMIRAN, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 21-5(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Some problems of galactic cosmic-ray modulation by the solar wind were solved to the anisotropic diffusion approximation: (1) The expected galactic cosmic-ray intensity in interplanetary space with discontinuous parameters of diffusion was found; (2) the solar-wind model with asymmetry in the form of a spherical sector with the center at the Sun was examined for several types of dependences of the diffusion parameters on the distance to the Sun; and (3) the model of a spherical modulation region into which the anisotropic flux of galactic cosmic rays falls was examined. The weakening of the anisotropy caused by the cosmic-ray flux interaction with the solar wind was established. (auth)

34047 CO-ROTATING MODULATIONS OF COSMIC-RAY INTENSITY DETECTED BY SPACECRAFTS SEPARATED IN SOLAR AZIMUTH. **Balasubrahmanyan, V. K. (Goddard Space Flight Center, Greenbelt, Md.); Roelof, E. C.; Bukata, R. P.; Palmeira, R. A. R. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 31-6(1970).**

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The daily cosmic-ray intensities from the IMP-C (Explorer XVIII) Geiger-counter monitor ($E_p \gtrsim 50$ MeV) and the Pioneer VI scintillation telescope ($E_p \gtrsim 7.5$ MeV) were statistically analyzed by the use of correlation functions. When the two spacecraft were close to each other, the cross-correlation function agreed closely with the autocorrelation function of either detector, showing that both detectors were responding comparably and reliably to cosmic-ray fluxes. When Pioneer VI and IMP-C were separated by ~50° (October to December 1966), the variations in the detector rates appeared to be mainly due to galactic cosmic rays. Solar flare contributions $\gtrsim$7.5 MeV were eliminated from the Pioneer VI data by regression analysis using low-energy rates (7.5 MeV $\lesssim E_p \lesssim$ 44 MeV). Comparison of IMP-C and neutron monitor rates showed no detectable variations in solar proton outflow of $E_p \gtrsim 50$ MeV. The cross-correlation function between the detectors during this quiet period reached a significant peak (0.67 ± 0.05) with a lag of ~3 days between data from IMP-C and Pioneer VI. Also, the cross-correlation function (displaced by −3 days) was qualitatively similar in form to the autocorrelation function from IMP-C. It is proposed that there are numerous long-lived regions of modulated cosmic-ray flux following the general spiral configuration of the interplanetary magnetic field as the field structure co-rotates with the Sun. This interpretation is consistent with the observations of recurrent Forbush decreases in early 1966 reported by McCracken, Rao, and Bukata. (auth)

34048 SPECTRUM OF THE COSMIC-RAY SOLAR DIURNAL MODULATION. **Jacklyn, R. M.; Duggal, S. P.; Pomerantz, M. A. (Franklin Inst., Swarthmore, Pa.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 47-54(1970).**

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A comprehensive analysis was carried out of measurements obtained over almost an entire solar cycle with a variety of detectors responding to primaries extending over the range 1 to 200 GV. Year-to-year changes in the amplitude of the daily variation were greater for experimental arrangements having higher mean rigidities of response. Furthermore, in contrast with neutron monitors, other detectors (inclined and underground meson telescopes) revealed marked changes in the phase. The average value of the upper cutoff rigidity above which the diurnal variation ceases was approximately 90 GV during the nine-year period 1958 through 1966, and the yearly averages ranged from about 55 to 100 GV. The need for exercising special caution in comparing available experimental results with the predictions of theoretical models of the diurnal anisotropy is indicated. (auth)

34049 VARIATIONS OF DIURNAL ANISOTROPY WITH PERIODS OF ONE AND TWO SOLAR CYCLES. **Duggal, S. P.; Forbush, S. E.; Pomerantz, M. A. (Franklin Inst., Swarthmore, Pa.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 55-9(1970).**

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An analysis of the limited data available from neutron monitors was conducted to determine separately the two components of the cosmic-ray diurnal anisotropy in the asymptotic directions 90 and 128° east of the Sun−Earth line. The variation of the latter as deduced from neutron monitor data was compared with the two solar-cycle wave derived from ionization chamber measurements. The amplitude for a high latitude neutron monitor was twice that for ionization chambers normalized to Cheltenham. Within the experimental uncertainties, the variational spectra of the anisotropies with periods of one and two solar cycles were the same. (auth)

34050 FIRST AND SECOND HARMONICS OF THE DAILY VARIATION RECORDED BY NM-64 NEUTRON MONITORS DURING 1965–68. **Willets, A. C.; Griffiths, W. K.; Hatton, C. J.; Marsden, P. L. (Univ. of Leeds, Eng.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 61-7(1970).**

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The first and second harmonics of the diurnal variation of cosmic-ray intensity recorded by NM-64 neutron monitors were derived for the period 1965−68. The amplitude of the first harmonic increased by ~35% from 1965−66 and remained constant thereafter. The phase was constant throughout. The index of the variational spectrum was consistent with zero, leading to a free-space amplitude and direction of anisotropy in 1965 of (0.26 ± 0.01)% and (94 ± 9)°E of the Earth−Sun line, respectively. For 1966−68 these were (0.38 ± 0.01)% and (95 ± 7)°E, respectively. The existence of a free-space second harmonic was demonstrated and its phase, amplitude, and energy dependence were examined. (auth)

34051 MEASUREMENTS OF THE COSMIC-RAY SOLAR DIURNAL VARIATION. **Sumner, D. J. (Makerere University Coll., Kampala, Uganda); Thomson, D. M.; Hashim, A.; Thambyahpillai, T. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 69-75 (1970).**

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The daily variations of cosmic-ray intensity were recorded by cubical inclined meson telescopes at Makerere, Uganda (geographic 0°20′N, 32°32′E) between 1965 and 1969 and at London, England (geographic 51°31′N, 0°6′W) between 1965 and 1968. The telescopes at Makerere were inclined at 45° to the zenith in the East and West directions; the telescopes at London were inclined at 45° to the zenith in the North and South directions. The annual means of the solar daily variation (24 hour wave) show an increase from 1965 to 1969 consistent with a co-rotation free-space amplitude of 0.4% in the 1800 hrs direction at all rigidities up to a limiting rigidity. The limiting rigidity varied from less than 50 GV in 1965 to about 100 GV in 1969. The semi-diurnal variation (12 hour wave) shows no such trend but the amplitudes and phases of the semi-diurnal variation recorded by all four detectors are consistent with a free-space modulation of the form $dJ/J = \alpha P \cos \Lambda$ up to an upper limiting rigidity lying between 200 and 300 GV, where $\alpha = (1.4 \pm 0.3) \times 10^{-3}\%\ GV^{-1}$. The directions of the maxima of the semi-diurnal variation in space make an angle of (140° ± 10°) with the Earth−Sun line, approximately perpendicular to the interplanetary field direction. No significant sidereal variations were found. (auth)

34052 SEMIDIURNAL ANISOTROPY OF COSMIC RADIATION IN THE ENERGY RANGE 1 TO 200 GeV. **Rao, U. R.; Agrawal, S. P. (Physical Research Lab., Ahmedabad, India). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 77-82(1970).**

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

From an analysis of the data from the worldwide network of neutron monitoring stations it is shown that the average semi-diurnal variation of cosmic radiation in the energy range 1 to 200 GeV: (a) is consistent with an anisotropy of 0.1%, with the maximum along the direction of 03 hours, i.e., perpendicular to the direction of the interplanetary magnetic field; (b) varies as the first power of rigidity; (c) varies as $\cos^2 \lambda$, where λ is the declination, and (d) is invariant with time during the period 1958−1968. (auth)

34053 SEMIDIURNAL ANISOTROPY OF COSMIC RADIATION. **Fujii, Z.; Fujimoto, K.; Ueno, H.; Kondo, I.; Nagashima, K. (Nagoya Univ., Japan). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 83-8(1970).**

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The average feature of cosmic-ray semi-diurnal anisotropy was studied with data obtained by means of a high counting rate multi-directional meson telescope at Mt. Norikura for the period Dec. 1967 to Oct. 1968. Cosmic-ray intensities from five different directions, East, South, West, North, and Vertical, were separately recorded with a counting rate of about 10^6/hr for each channel. Analysis was made using difference vectors such as South−East, West−East, North−East, and Vertical−East in order to eliminate atmospheric effects and worldwide isotropic variations. A form of the rigidity spectrum for the semi-diurnal anisotropy in interplanetary space is assumed to be $aP^{\gamma} \exp(-P/P_0)$, where P is the rigidity and a, γ, and P_0 are parameters. This form gives a better agreement with observation than the simple power-law spectrum P^{γ}. It is shown that the average semi-diurnal anisotropy in interplanetary space has its peak amplitude at above 70 GV, and that the average direction of the anisotropy is at about 3 hr LT. (auth)

34054 EFFECTIVE ANGLES OF ACCEPTANCE AND THE ENERGY SPECTRUM OF THE DIURNAL VARIATION. Chaloupka, P.; Dubinsky, J.; Fischer, S.; Kowalski, T. (Inst. of Experimental Physics, Kosice, Czech. Geophysical Inst., Warsaw). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 89-94 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The effective angles of geomagnetic bending may be determined from the temporal correlation functions of cosmic-ray intensities. One can find the effective directions using the values of the temporal shift which gives the maximum correlation coefficient, when the effective angle for one of the two stations is known. For this purpose the data from some stations which have effective directions independent of the energy spectrum have to be correlated with the data from other stations. Because the value of the correlation coefficient depends on the amplitude of the cosmic-ray variations, it can be used as a characteristic of the degree of cosmic-ray activity. From the shape of the temporal correlation function the role of the isotropic and anisotropic variations and their relations can be estimated. To determine the power-law rigidity spectrum of the diurnal variation the method using a comparison of the real and predicted ratios of the amplitudes at two stations is examined. Then an attempt to determine the spectrum from the differences of the phases is made but the results are very uncertain. The values of the temporal shift corresponding to the maxima of the temporal correlation functions are compared with the expected values for the various spectra of the diurnal variations. (auth)

34055 STATISTICAL RELIABILITY TESTS OF COSMIC-RAY INTENSITY DATA. Dyring, E.; Sporre, B. (Uppsala Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 95-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A system of statistical methods to test on a routine basis the reliability of cosmic-ray intensity records from ground stations is presented. The methods include both internal comparisons of the individual sections of the instrument and comparisons with data from other stations. It is stressed that the time series aspect is essential. (auth)

34056 LATITUDE EFFECT ON SOLAR DIURNAL VARIATIONS OF COSMIC-RAY INTENSITIES. Kitamura, M. (Meteorological Research Inst., Tokyo). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 99-104(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The latitude effect on the cosmic-ray diurnal variation was analyzed to reexamine the model of the two-way anisotropy for the diurnal variation of cosmic rays. It is shown that the latitude effect is also explained by a model proposed in a previous paper (1968) in which there exist two anisotropies in interplanetary space (one of them, Δj_1, from an "antigarden-hose" direction and the other, Δj_2, from a "garden-hose" direction), producing the solar diurnal variation of the cosmic-ray intensity on the Earth. When the energy spectra of Δj_1 and Δj_2 are represented by $k_1 j_0(E) \cdot (E_0/E)^{m_1}$ and $k_2 j_0(E) \cdot (E_0/E)^{m_2}$, respectively, where $j_0(E)$ is the normal differential energy spectrum of the primary cosmic rays, then the values of $k_1 \sim 2\%$ and $k_2 \sim 0.2\%$ to the normal differential intensity at 10 GeV are obtained for $m_1 \sim 1$, $m_2 \sim 0$ and the cutoff at ~10 GeV on the low energy side of the spectra of both Δj_1 and Δj_2, by comparing theoretical values with observations of the latitude effect of the cosmic-ray diurnal variations. (auth)

34057 APPROXIMATIONS IN THE THEORY OF SOLAR-CYCLE MODULATION. Fisk, L. A. (Goddard Space Flight Center, Greenbelt, Md. Univ. of California, San Diego, La Jolla); Gleeson, L. J.; Axford, W. I. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 105-10(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

It is shown that the force-field model for the modulation of galactic cosmic rays is in good agreement with analytic and numerical solutions of the Fokker–Planck equation at intermediate and high energies. The associated anisotropy is outward at high energies. Approximate equations are derived for the low-energy regime, and it is shown that the observations of the spectrum, intensity gradient, and anisotropy of galactic cosmic rays in the kinetic energy range 7.5 to 45 MeV are not necessarily inconsistent. (auth)

34058 MEASUREMENTS OF GRADIENTS AND ANISOTROPIES OF COSMIC RAYS IN INTERPLANETARY SPACE: PIONEER 8. Lezniak, J. A.; Webber, W. R. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 111-18(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Measurements of the interplanetary cosmic-ray gradient in various energy intervals above 12 MeV made on the Pioneer 8 space probe in 1968 are reported. In general the gradient is consistent with zero although a small positive gradient may be present at some energies. The measurements also indicate that no significant anisotropies are present above an energy of ~240 MeV to an accuracy of a few tenths of a percent. (auth)

34059 COMPARISON OF SOLAR MODULATION EFFECTS ON PROTONS, ELECTRONS, AND HELIUM NUCLEI. Lezniak, J. A.; Webber, W. R.; Rockstroh, J. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 119-23 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Measurements of the proton and helium spectra made in 1968 on the Pioneer 8 space probe are summarized. The energy dependence of the solar modulation of these nuclei between 1965 and 1968 is determined and compared with that measured for electrons. A number of new features of the modulation are pointed out. These features cannot be explained by the simple diffusion-convection theory for the modulation of cosmic rays, however models which incorporate energy loss effects provide an explanation for most of these features. (auth)

34060 RADIAL GRADIENT OF 0.3-MeV PROTONS IN INTERPLANETARY SPACE MEASURED WITH MARINER 5. Krimigis, S. M. (Johns Hopkins Univ., Silver Spring, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 125-32(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Simultaneous observations of low-energy ($E_p \gtrsim 0.32$ MeV) protons during the second half of 1967 were obtained using intercalibrated solid-state detectors on the Venus-bound Mariner 5 and the Earth-orbiting Explorer 33 spacecraft. There was substantial solar activity during most of this period with minimum counting rates being observed during days ~240 to 248. Even during this time interval, however, a minimum flux of ~0.2 $(\mathrm{cm}^2\ \mathrm{sec\ sr})^{-1}$ of $E_p \gtrsim 0.32$ MeV was observed by Mariner 5, and a flux of ~0.1 $(\mathrm{cm}^2\ \mathrm{sec\ sr})^{-1}$ by Explorer 33. Assuming this period to represent a steady-state situation of the interplanetary medium, a radial gradient of $(-350 \pm 80)\%/\mathrm{AU}$ is obtained for protons of $E_p \gtrsim 0.32$ MeV. This value of the gradient is consistent with a purely solar source in this energy range, and is in basic disagreement with the diffusion-convection theory of cosmic rays. This result, taken together with other related observations, suggests that the Sun is an important contributor to the steady-state interplanetary particle population up to energies of at least 50 MeV/nucleon. (auth)

34061 SOLAR DIURNAL VARIATION OF COSMIC RAYS UNDERGROUND SINCE 1958. Regener, V. H.; Swinson, D. B.; Ericksen, J. H.; Ahluwalia, H. S. (Univ. of New Mexico, Albuquerque). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 133-7 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The results from underground recordings of the cosmic-ray flux since 1958 in Bolivia and in New Mexico are reviewed, together with details of the experimental technique. At the present time, three stations are in operation. Two of these are at vertical depths of 25 and 40 MW(e) in Bolivia and in New Mexico, respectively. The third station is at 80 MW(e) in New Mexico. At each station, there are multiple twofold coincidence scintillator telescopes, one of 4 m² area pointing vertically, and four others at 2 m² area slanting toward north, east, west, and south. The results are presented in terms of the variability of the characteristics of the diurnal variation with the phase of the solar cycle, with depth, with telescope inclination, and with the interplanetary magnetic field. (auth)

34062 SOLAR DIURNAL VARIATION OF COSMIC-RAY INTENSITY UNDERGROUND DURING SOLAR ACTIVITY CYCLE-20. Ahluwalia, H. S.; Ericksen, J. H. (Univ. of New Mexico, Albuquerque). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 139-46(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The University of New Mexico operates plastic scintillator directional (V, E, W, N, S) telescopes at two underground locations at depths varying from 30 to 60 mwe. One site is located at Mt. Chacaltaya (68°W 16°S) in Bolivia and the other at Embudo (106°W 35°N) in the Sandia Mountains near Albuquerque in New Mexico. Data from these underground detectors were analyzed to study the characteristics of the solar diurnal variation of the cosmic-ray intensity during the period 1965–1968. It was found that the observed solar diurnal variation mainly results from an extraterrestrial anisotropy having a continuously increasing upper cut-off rigidity R_c. For the period 1965 to 1968, R_c increases from about 43 to 90 GV. Time-correction vectors were also obtained applicable to these data due to the geomagnetic "bending" of the free-space cosmic-ray flux and the "orbital" effect related to Earth's orbital motion around the Sun. The corrected data indicated that the direction of the anisotropy, within errors of observations, was at 90°E of the Earth–Sun line. The physical significance of the results is discussed. (auth)

34063 SECOND SPHERICAL HARMONICS IN THE DISTRIBUTION OF COSMIC RAYS. Krivoshapkin, P. A.; Krymskii, G. F.; Kuzmin, A. I.; Skripin, G. V.; Metlyaeva, E. A. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 147-51(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The screening mechanism in a magnetic sector is suggested as an explanation of the existence of the spherical harmonics in cosmic-ray intensity distribution. The spectrum of this distribution is found experimentally. The orientation of the interplanetary magnetic field is investigated by means of the data of the worldwide network of neutron monitor stations for the years 1959, 1964, and 1965. (auth)

34064 CHANGES OF DEGREE OF INHOMOGENEITY OF THE INTERPLANETARY MAGNETIC FIELD WITH SOLAR ACTIVITY. Kuzmin, A. I.; Skripin, G. V.; Filippov, V. A. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 153-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Average annual diurnal and semi-diurnal variations of the muonic component recorded by means of ground based and underground equipments at Yakutsk were analyzed. Data for 11 years (1957–1968) were divided into 5 two-year periods for which energy spectra of the first and second harmonics of the diurnal variation were calculated. It has been shown that the spectra of both harmonics become softer if the solar activity decreases. The results are interpreted in terms of the diffusion mechanism and the model of cosmic-ray screening by a radial interplanetary magnetic field. (auth)

34065 DIURNAL VARIATIONS OF COSMIC-RAY INTENSITY OBSERVED 70 mwe UNDERGROUND. Antonucci, E.; Cini Castagnoli, G.; Dodero, M. A. (CNR, Turin. Univ., Turin). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 157-61(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Some results of a study of diurnal intensity variations of high-energy galactic cosmic rays observed at Mt. Cappuccini, Torino, during the years 1966–68 are presented. These variations are examined under two aspects: by studying average values over lengthy periods or on a day-to-day basis. Experimental results are compared with those derived by McCracken, taking into account the high-energy particle trajectories in the sectorial interplanetary magnetic field. (auth)

34066 ANALYSIS OF ANNUAL AND SEMI-ANNUAL PERIODICITIES IN NEUTRON-MONITOR DATA. Schneider, S. M.; Korff, S. A. (New York Univ., N. Y.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 163-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An analysis was performed to determine the amplitudes and phases of IGY-type neutron-monitor data at frequencies of 1 and 2 cycles/year. Least-squares trend and spectral analyses were simultaneously performed to produce "raw" spectral estimates upon which convolutions (following standard spectral analysis) were performed. The data thus far analyzed shows that the annual and semiannual amplitudes, but not the phases, are rigidity dependent; and the amplitudes increase with increasing solar activity. The results show points of possible agreement with those of other investigators who used different methods to account for trends in the data. Possible application of the procedures to the analysis of long-term variations in the diurnal periodicity is indicated. (auth)

34067 DETERMINATION OF HELIOCENTRIC COSMIC-RAY DENSITY GRADIENT USING NEUTRON-MONITOR DATA. Bercovitch, M. (National Research Council of Canada, Ottawa). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 169-76(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The radial cosmic-ray density gradient produces within an interplanetary magnetic sector a north–south streaming which reverses direction with reversal of the magnetic field. The magnetic sector associated changes of neutron intensity for a series of monitors ranging in asymptotic latitude from +85° to −80° were analyzed to yield an estimate of the radial density gradient during 1964–65. Assuming a $(\text{rigidity})^{-1}$ dependence for rigidity >2 GV, the value obtained was 3 to 14 times smaller than the gradient measured directly by O'Gallagher and Simpson on Mariner 4. (auth)

34068 YEARLY VARIATION OF THE COSMIC-RAY INTENSITY FROM 1963–1967: ITS RELATION TO THE OBSERVED VARIATION OF SOLAR ACTIVITY WITH HELIOLATITUDE AND TIME. Barker, M. C.; Hatton, C. J. (Univ. of Leeds, Eng.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 177-81(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A study of the yearly variation of the cosmic-ray intensity was made using pressure corrected neutron monitor data for the years 1963–1967 inclusive. Atmospheric temperature effects were minimized by using data of three stations from both the northern and southern hemispheres. The yearly cosmic-ray variations are shown to be consistent with the observed heliolatitude distribution of coronal 5303 Å emission if the Earth's motion relative to the solar equatorial plane is taken into account. The amplitude of the annual wave is variable from year to year having a maximum value ≈ 1% in 1963 and 1965. The cosmic-ray gradient across the solar equatorial plane is calculated to be ≈ 8%/AU during these years. A phase lag of 1 month is found to exist between the solar activity and cosmic-ray intensity during the period suggesting a solar cavity radius ≈ 7 AU. (auth)

34069 EXPECTED DISTRIBUTION OF THE INTENSITY OF GALACTIC COSMIC RAYS IN INTERPLANETARY SPACE IN CASE OF A SPHERICALLY ASYMMETRIC SOLAR WIND. Dorman, L. I. (IZMIRAN, Moscow); Kobilinskii, Z. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 183-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Solutions are presented of quasistationary equations of the isotropic diffusion of galactic cosmic rays in interplanetary space based on various assumptions about the character of the dependence of solar-wind velocity and diffusion coefficient upon heliolatitude and heliolongitude. Numerical calculations resulted in finding the cosmic-ray density as a function of the distance from the Sun depending on heliolatitude and heliolongitude for various models of solar-wind distribution. The expected radial and transverse gradients of the cosmic-ray density were also determined. (auth)

34070 UNDERGROUND RESPONSE FUNCTIONS AND UPPER LIMITING RIGIDITY TO SOLAR MODULATION. Peacock, D. S. (Univ. of Denver). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 189-94(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Underground meson monitors provide valuable information on the modulation of primary cosmic rays of energy ≈ 100 GeV so long as their response functions are accurately known. Previously these response functions were calculated either (i) by a method due to Dorman or (ii) by a semi-theoretical approach using a model for the nuclear interaction. Method (ii) was used to improve previous calculations by using the Trilling formula which fits the pion production spectra for primary protons of energies up to 30 GeV. Assuming the Trilling formula is applicable up to energies ≈ 100 GeV, new response functions were calculated for the Holborn underground detectors at 60 mwe. These new response functions now peak around 80 GeV compared with 120 GeV for those previously used. This modifies the previously presented results on the upper limiting rigidity to the diurnal variation, reducing the estimated value from about 130 to 90 ± 10 GV. (auth)

34071 STUDY OF PROTON FLUXES IN THE RANGE 1.5 TO 50 MeV ON THE ZOND-4 AND ZOND-5 SPACE PROBES. Konstantinov, B. P.; Bredov, M. M.; Kolchin, A. A.; Lebedev, V. V.; Skrebtsov, G. P. (Ioffe Inst. of Physics and Tech., Leningrad). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 195-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A study of 1.5 to 50-MeV proton fluxes was carried out on Zond-4 and Zond-5 space probes. Numerical values of proton flux intensities in the ranges 1.5 to 10, 10 to 21, 30 to 35, and 45 to 50 MeV are presented. (auth)

34072 27-DAY VARIATIONS OF SOLAR ACTIVITY AND COSMIC-RAY INTENSITY AND THE DETERMINATION OF THE EFFECTIVE SIZE OF THE ASYMMETRIC SOLAR WIND. Alaniya, M. V.; Shatashvili, L. K. (Inst. of Geophysics, Tbilisi, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 199-202 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The harmonic coefficients of 27-day Fourier expansion of the daily average values of the cosmic-ray neutron component N and of the sunspot numbers W were studied. The data on the cosmic-ray neutron component of the Climax station, obtained during m = 107 revolutions of the Sun were taken as initial data. It was found that, as a rule, some time delay m existed (a shift of revolutions of the Sun) of maxima of the amplitudes of 27-day variations of the parameter N with respect to the parameter W. If the number of sunspots W is taken as the index of the solar activity level, then during some epochs of the solar activity the radius of the asymmetric solar-wind volume may reach some tens of A.U. The analysis shows that if m is determined by the time of disappearance (or the largest decrease of the amplitudes) of 27-day variations in different parameters, then the value of m obtained is m ≥ 2 revolutions of the Sun (if the delay time m is counted relative to the corresponding variations of the parameter W), and m ≥ 1 revolution of the Sun (if the delay time m is counted relative to 27-day variations of the coronal emission λ = 5303 Å. (auth)

34073 27-DAY COSMIC-RAY INTENSITY VARIATIONS IN 1967. Bazilevskaya, G. A.; Okhlopkov, V. P.; Charakhchyan, T. N. (Moscow State Univ. Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 203-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Distinct 27-day cosmic-ray intensity variations with amplitudes of (2.5 ± 0.2)% in stratosphere and (1.0 ± 0.2)% according to neutron monitor data were observed in the first half of 1967. The 27-day variation of solar activity indices (Wolf numbers, W, and 2800 MHz radioemission flux, F) has been established to be well pronounced during this period. The change of the 27-day variation amplitude in time is considered and the peak of the 27-day cosmic wave amplitude is shown to be observed 60 to 70 days later than the peak of amplitudes of W and F. (auth)

34074 27-DAY RECURRENCY IN COSMIC-RAY INTENSITY AND GEOMAGNETIC K_p DATA. Dyring, E.; Hauska, H.; Kangedal, Brigitta (Inst. of Physics, Uppsala). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 209-14(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A 27-day recurrency effect has been observed in many types of interplanetary and geophysical data associated with the rotation period of 27 days of the Sun. Daily geomagnetic K_p-data during the period 1932—1968 and daily cosmic-ray intensities of the Deep River NM 64 neutron monitor, 1962—1968, were analyzed to examine the periodical variations in the frequency band 0.02—0.2 c/days. Filter and power spectrum methods were used on a yearly and bi-yearly basis. Generally, a well defined 27-day recurrency effect was observed in both geomagnetic and cosmic-ray data. However, the shape and the largeness of the effect varied considerably from year to year and between the two types of data. The geomagnetic K_p-data showed marked overtones of the 27-day period for many years, which was not observed in the cosmic-ray data. These overtones, when being prominent, were tentatively associated with the quasi-stable sector structure in the interplanetary magnetic field. Using a band pass filter the 27-day waves in the cosmic-ray intensity were uncovered. This operation was repeated after excluding some prominent Forbush decreases. (auth)

34075 INVESTIGATION OF THE 27-DAY PERIODICITY OF THE COSMIC-RAY INTENSITY 40 mwe UNDERGROUND. Kota, J.; Somogyi, A.; Valas, G.; Varga, A. (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 215-17(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The existence of a 27-day persistent wave was checked in the intensity of the cosmic-ray muonic component measured at a depth of 40 mwe underground at Budapest during the years 1958—1963. The maximum likelihood method with simultaneous meteorological corrections was used to analyze the data. No indication was found for either a 27- or a 27.3-day wave. (auth)

34076 CORRELATION OF SOLAR ACTIVITY WITH COSMIC-RAY INTENSITY AND SOLAR-WIND PROPERTIES. Gushchina, R. T. (IZMIRAN, Moscow); Dorman, I. V.; Dorman, L. I.; Pimenov, I. A. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 219-25(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

It is shown that the effective dimension of the cosmic-ray modulation region determined from the delay of cosmic-ray intensity changes with respect to the changes of the various solar activity parameters is substantially dependent on the value of the data averaging period as well as on the solar activity epoch. It should be taken into consideration, however, that the delay may be due partly to the phenomenon of displacement of the active zone on the Sun from high to low heliolatitudes in the course of the solar activity cycle. The correlation between the cosmic-ray intensity observed at different stations and the index HL in the period of the solar activity cycle are found. The analysis of the obtained hysteresis diagrams permits one to obtain certain information on the dependence of the solar-wind modulation characteristics on heliolatitude. (auth)

34077 COSMIC-RAY INTENSITY INCREASES BEFORE FORBUSH EFFECTS. Dorman, L. I.; Kaminer, N. S.; Kebuladze, T. V. (IZMIRAN, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 227-31(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The dependence of intensity increases in the cosmic-ray neutron component before Forbush effects on the corpuscular stream velocity, K_p-indexes and helio-coordinates of chromospheric flares is studied. The conclusion is drawn that the Forbush decreases and magnetic storms are created by the shock wave generated by the corpuscular stream. (auth)

34078 COUPLING AND BAROMETER COEFFICIENTS FOR MEASUREMENTS OF COSMIC-RAY VARIATIONS AT ALTITUDES OF 260 TO 400 mb. Dorman, L. I. (IZMIRAN, Moscow); Fedchenko, S. G.; Granitskii, L. V.; Rishe, G. A. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 233-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Latitude—longitude distribution of cosmic-ray intensity in the altitude range with pressures of 260 to 400 mb were obtained in a period of low solar activity. The coupling coefficients were calculated on the basis of the dependence of cosmic-ray intensity on geomagnetic cut-off rigidity R_c. On the basis of the dependence of cosmic-ray intensity on the altitude for the points with different R_c the barometer coefficients were obtained as a function of R_c. The problem of approximation of latitude effect and coupling coefficients is also discussed. (auth)

34079 CHARACTERISTICS OF COSMIC-RAY FLUCTUATIONS IN THE FREQUENCY RANGE OF 10^{-6} TO 4.15×10^{-3} CYCLES PER SECOND. Dhanju, M. S.; Sarabhai, V. (Physical Research Lab., Ahmedabad, India). Acta Phys. Acad. Sci. Hung.; 20: Suppl. 2, 237-40(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The frequency dependence of the power spectrum of the μ meson intensity recorded at Chalcaltaya (Bolivia) was investigated for periods ranging from 7 days to 4 minutes. Two sets of meson data of record length 27 days from November 24 to December 20, 1965 and February 22 to March 20, 1966, were analyzed. The corresponding pressure records for these two sets were also subjected to similar analysis. Different regions of the frequency spectrum showed different values of exponent for a power law fit. Comparison was made with the spectrum of the interplanetary field reported by Jokipii and Coleman (1968). (auth)

34080 SEARCH FOR RAPID PERIODIC VARIATIONS IN THE GALACTIC COSMIC-RAY INTENSITY. Ruthberg, S. (Uppsala Univ.); Dyring, E.; Lindgren, S.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 241-5(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Little work has been done in searching for persistent periodic variations in the frequency region opened by the new powerful cosmic-ray instruments with high counting rates. 5-min data from the NM 64 neutron monitor in Oulu, the IGY neutron monitor in Uppsala, and a meson scintillation telescope in Uppsala over the period January 1 to March 23, 1969, were studied. Different time series methods were used in an attempt to extract periodic variations in the frequency range 0.12 to 6 c/h. The results showed no trace of periodic variations for this particular period. However, a significant peak was found at 0.5 c/h for the period August 20 to October 23, 1967, in the Uppsala IGY neutron monitor. It seems reasonable to study periodic and nonperiodic short-term variations more systematically. (auth)

34081 SEARCH FOR SHORT-PERIOD COSMIC-RAY INTENSITY PULSATIONS. Ageshin, P. M.; Bazilevskaya, G. A.;

Zatsepin, V. I.; (and others) (Lebedev Inst. of Physics, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 247(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Balloon measurements were carried out to get the amplitudes of the short-period pulsations of cosmic rays in the stratosphere. (auth)

34082 COSMIC-RAY CURRENTS IN STATIONARY STREAMS OF SOLAR PLASMA. Krymskii, G. F.; Altukhov, A. M.; Kuzmin, A. I.; Skripin, G. V. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 249-51(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Results of an analysis of data obtained at various neutron supermonitor stations during November 16–21 and December 12–17, 1966 are presented. The changes of the vector of anisotropy of cosmic-ray intensity are investigated in detail. (auth)

34083 METEOR EFFECTS OF COSMIC RAYS. Belskii, S. A. (Ioffe Inst. of Physics and Tech., Leningrad). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 253-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Data are presented on the meteor effect in cosmic rays during the period 1957–1968. The effect is connected with the existence of regular magnetic fields which arise in charged micrometeor streams traversing the interplanetary plasma. The magnetic field in micrometeor streams is of the same order of magnitude as that observed in interplanetary space. It is suggested that meteor effects are due both to individual meteor streams (local effect) and to all the meteor streams acting as a whole owing to modulation of solar and galactic cosmic rays by clouds of magnetic inhomogeneities. It is noted that the magnetic fields of the meteor streams are the generators of magnetic fields in space. (auth)

34084 MICROVARIATIONS OF COSMIC-RAY INTENSITY. Chirkov, N. P.; Ipat'ev, V. I. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 257-60(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Twenty to 60 minute cosmic-ray intensity variations were investigated using data from the neutron supermonitor at Tixie. The frequency spectrum of microvariations was obtained in the form $A(f) = B \cdot f^{-0.5}$ for the frequency interval $(2.8 \text{ to } 8.4)10^{-4}$ Hz. The nature of the cosmic-ray microvariations is discussed. (auth)

34085 QUIET-TIME FLUXES OF PROTONS AND α-PARTICLES IN THE ENERGY RANGE OF 2 TO 20 MeV/NUCLEON IN 1967. Fan, C. Y. (Univ. of Arizona, Tucson); Gloeckler, G.; McKibben, R. B.; Simpson, J. A. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 261-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The quiet-time fluxes and differential spectra of protons and alpha particles in the energy range 2 to 20 MeV/nucleon were measured in 1967 with cosmic-ray detectors on the OGO-3 satellite. These measurements are a continuation of similar studies, begun in 1964, of the temporal variation of the spectra of these particles. The results obtained from the period 1964 to 1966 indicated that these particles were a mixture of particles of galactic and solar origin. The 1967 measurements show that, despite an increase in solar activity and modulation of relativistic cosmic rays, the 2 to 20 MeV fluxes of protons and alpha particles remained relatively unchanged. The implications of this result are discussed. (auth)

34086 MODULATION AND HELIOCENTRIC GRADIENT OF LOW-ENERGY COSMIC RAYS NEAR SOLAR MINIMUM IN 1965. Kane, S. R.; Winckler, J. R. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 269-74(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Cosmic-ray total ionization measurements made in space near the Earth with the OGO-I and OGO-III ion chambers are compared with other cosmic-ray measurements in space and on the ground. The findings are: (i) The observations in 1964–1965 are consistent with a heliocentric gradient of $\approx 0\%$ per AU in the range 1.0 to 1.28 AU and probably also in the range 1.0 to 1.56 AU. (ii) As compared to the recovery phase (before May 1965) the apparent long-term modulation of the low-energy (>12 MeV per nucleon) particles was relatively less during the early decreasing phase (June 1965–December 1966) giving rise to the "hysteresis" effect. The observed effect, which was maximum ($\approx 13\%$) from June 30, 1966 to July 4, 1966, disappeared completely by April 22–28, 1967. (iii) The hysteresis effect is probably a characteristic of the modulation mechanism. It is not likely to be due to the time variation of a quiescent flux of energetic solar particles. (iv) The energy dependence of the recovery phase of the 11-year variation is in general different from that for the recovery phase for Forbush decreases. (auth)

34087 EFFECTS OF SOLAR MODULATION ON THE ENERGY SPECTRUM OF HEAVY COSMIC-RAY NUCLEI. Cleghorn, T. F.; Freier, P. S.; Waddington, C. J. (Univ. of Minnesota, Minneapolis). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 275-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The intensity and energy spectra of VH-nuclei ($20 \leq Z \leq 30$) were studied in nuclear emulsions flown from Fort Churchill in 1968. An attempt was made to determine the form of the energy spectrum at low energies in order to study the effects of solar modulation. Provisional results of relatively low statistical weight are reported. An integral intensity of $J(E > 230 \text{ MeV/N}) = 0.96 \pm 0.8$ nuclei/m^{2}sec sr was measured. Differential intensities were found below 800 MeV/N of approximately 0.5 nuclei/m^{2}sec sr GeV/N, factors of 2 to 3 times less than those obtained near solar minimum. This amount of modulation is appreciably more than would have been predicted from the variation of helium nuclei over the solar cycle. (auth)

34088 SOLAR MODULATION OF GALACTIC COSMIC RAYS WITH A TWENTY-YEAR PERIOD: INTERPRETATION AND INFERENCES. Schatten, K. H.; Wilcox, J. M. (Univ. of California, Berkeley. Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 279-84(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The diurnal anisotropy component of galactic cosmic rays arriving at the Earth from the asymptotic direction 128°E of the Sun has been found to possess a twenty-year periodicity by Forbush. This twenty-year wave is suggested as evidence for magnetic reconnection between the nearby galactic field and field lines in the polar regions of the heliosphere during one half of the twenty-year solar magnetic cycle. This interpretation leads to the result that the component parallel to the solar rotation axis of the nearby galactic field is northward directed. The magnitude of the diurnal anisotropy allows an upper limit of 1 AU to be placed on the thickness of the heliosheath. This is based upon 60 AU as the assumed radius of the heliosphere from pressure equilibrium considerations. (auth)

34089 COSMIC RAYS AND THE 11-YEAR SOLAR ACTIVITY CYCLE. Salimzibarov, R. B.; Shafer, Yu. G. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 285-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

On the basis of measurements carried out on satellites and geophysical rockets in 1958–1967 it has been found that the amplitudes of the secular variation of the integral flux of cosmic rays and the average ionizing capacity of cosmic-ray particles with rigidities 4 to 5 GeV amount to 15 to 18% and 35 to 40%, respectively. Experimental values of the changes of the flux and the ionizing capacity are compared with the values calculated on the basis of the "open" model of cosmic-ray modulation region. The comparison shows that modulation of primary cosmic rays with charges $Z \geq 2$ takes place in the transition region between the solar wind and the interstellar medium, while the modulation of cosmic-ray protons takes place within the inner volume of interplanetary space surrounded by the transition region. (auth)

34090 EVIDENCE FOR RESIDUAL MODULATION LEFT OVER FROM THE 1954–1964 SOLAR CYCLE. Neher, H. V. (California Inst. of Tech., Pasadena). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 289-94(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The activity of the Sun during the 1954–1964 solar cycle (No. 19) was greater than for any other so far recorded. Records extend back to the year 1750 A.D. Solar activity for the present cycle (No. 20) is close to the average. Cosmic-ray balloon data at Thule, Greenland indicate that the large hysteresis loop associated with cycle No. 19 did not close. Furthermore, the cosmic-ray intensity at balloon altitudes for the present cycle is lower at a given pressure and solar activity (as measured by sunspot numbers) than during cycles No. 17 and 18. It is suggested that this may be due to a residual modulation occurring at great distances which is left over from the large outbursts of solar plasmas during cycle No. 19 and which have not yet dissipated. (auth)

34091 SYNOPTIC ANALYSIS OF THE COSMIC-RAY NEUTRON-MONITOR DAILY DATA FOR THE STUDY OF MODULATION PROBLEMS. Bachelet, F. (Univ., Rome. CNR, Rome); Fazzini, M. C.; Iucci, N.; Villoresi, G.; Sporre, B. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 295-300(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The daily cosmic-ray neutron intensities recorded at some 40 stations for the period July 1957 to December 1962 were re-corrected for pressure variations by using appropriate pressure coefficients, i.e. coefficients changing with latitude, altitude, and solar cycle phase. Analysis was then performed in order to identify and estimate the step-like changes in the station efficiency so as to correct the data also for this effect. The data from 4 latitude surveys carried out by the Uppsala group in cooperation with the Bartol Research Foundation from July 1957 to February 1959 were also studied. Within each survey the data were properly corrected for pressure changes and for primary variations by using the "corrected" data from the available sea level stations (about 30). After a check of the consistency of the ship data and of the station network data, the latter were normalized by means of the former so as to obtain accurate daily latitude curves, suitable for the study of the medium- and long-term modulation. (auth)

34092 ROLE OF HELIOLATITUDES OF SUNSPOTS IN 11-YEAR GALACTIC COSMIC-RAY MODULATION. Stozhkov, Yu. I.; Charakhchyan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 301-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

It follows from the analysis of the 11-year cosmic-ray intensity modulation and 11-year solar activity cycle characterized by spot group number that the modulation amplitude depends not only on spot number but also on the mean heliolatitude of the spots. Consideration of such dependence makes it possible to explain the phenomenon of so-called hysteresis in cosmic rays. Treatment of experimental data has shown that the properties of corpuscular streams responsible for the cosmic-ray intensity modulation are changed with a change in the heliolatitude of a sunspot group. (auth)

34093 SOLAR ACTIVITY AND DIMENSION OF MODULATION REGION. Kolomeets, E. V.; Shakhova, Yu. A.; Zusmanovich, A. G. (Kazakh State Univ., Alma-Ata, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 305-10(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A determination of the modulation region of the galactic cosmic rays by the solar wind is carried out. To determine the solar activity index the correlation coefficients between cosmic-ray intensity, sunspot number, radiation of coronal lines for different heliolatitudes, and solar radiation of radio frequencies at about 200 to 9400 MHz for the period of 1957–1967 are estimated. The calculations of the modulation region dimensions are given for different periods of the solar activity cycle determined in accordance with ground and stratospheric data. The radiation of the corona has been found to be the index of solar activity characterizing the modulation of cosmic rays in interplanetary space in the best way. A solution of the equation of cosmic-ray diffusion in the modulation region has been found, taking into account the energy losses. (auth)

34094 VARIATION OF THE SECONDARY COSMIC-RAY SPECTRA DUE TO SOLAR MODULATION. Allkofer, O. C.; Dau, W. D. (Univ., Kiel). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 311-17(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Starting from the primary spectrum at minimum and maximum solar activity the nucleon and muon spectra are derived using a diffusion method and a conventional model for the nucleon–air collision and pion production. The modulation of the differential secondary cosmic-ray spectra is calculated in its dependence on atmospheric depth and the geomagnetic cut-off. The results are compared with experimental facts. (auth)

34095 COSMIC-RAY MODULATION DURING FORBUSH DECREASES IN 1968–1969. Lockwood, J. A.; Singh, P. (Univ. of New Hampshire, Durham). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 319-25(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

For several Forbush decreases in 1968–69 analyses were made of the counting rate variations of neutron monitors at different cutoff rigidities, of the different neutron multiplicities recorded by the Mt. Washington and Durham monitors, and of the cosmic-ray telescope on Pioneer 8. Comparisons of the Forbush decrease changes with those for the 11-year variation indicate that the Forbush decreases are less rigidity dependent. From these data a possible form for the rigidity modulation is obtained. (auth)

34096 SPECTRAL VARIATIONS IN SHORT-TERM (FORBUSH) DECREASES AND IN LONG-TERM CHANGES IN COSMIC-RAY INTENSITY. Balasubrahmanyan, V. K. (Goddard Space Flight Center, Greenbelt, Md.); Venkatesan, D. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 327-36(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Data are available from satellites IMP A, B, and C and OGO A on a continuous basis over the period November 1963–May 1967. The cosmic-ray intensity registered by GM counters on these satellites, of energy $\gtrsim 50$ MeV is compared with the intensities recorded by neutron monitors, at the equatorial station, Huancayo, at the high latitude station, Deep River, and at the polar station, Alert. Spectral variations during the Forbush decreases and during long term changes in cosmic-ray intensity are investigated, and the results discussed in terms of current ideas. (auth)

34097 NEW APPROACH TO STUDY OF COSMIC-RAY MODULATION ANISOTROPY. Chasson, R. L.; Gold, R. E.; Lal, S.; Peacock, D. S. (Univ. of Denver). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 337-44(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The Denver multidirectional muon telescope data were used in conjunction with a selected worldwide distribution of neutron monitor results to examine the morphology and spectrum of three major cosmic-ray modulation events: March 23, 1966; May 25, 1967, and January 26, 1968. Special attention was paid to the phenomenon of a predecrease of intensity followed by a Forbush event (January 26, 1968). An assessment was made of the power of multidirectional meson observations as a tool to study important modulation parameters, especially in the pre-Forbush phase of an approaching blast wave. (auth)

34098 ANOMALOUS STREAMING OF COSMIC RAYS. Lindgren, S. (Uppsala Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 345-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A description is given of three cases of pronounced cosmic-ray anisotropy in which the excess flux of GeV protons comes from the 6–12 hour quadrant outside the geomagnetic field. It is argued that the observed streaming is due to restoration processes triggered by a severe reduction of the cosmic-ray density east of the (extrapolated) Sun–Earth line. (auth)

34099 TRANSIENT NORTH–SOUTH ASYMMETRIES OF COSMIC RADIATION. Duggal, S. P.; Pomerantz, M. A. (Franklin Inst., Swarthmore, Pa.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 351-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Following the discovery of a transient axial anisotropy that occurred during the cosmic-ray storm of March 23, 1966, a search was made for other north–south asymmetry events that might have occurred since the advent of high counting rate neutron monitors. Roughly one out of three Forbush decreases displayed this phenomenon during the 1964–1966 solar minimum epoch in which eight distinct north–south asymmetry events were identified. The event commencing on September 14, 1966, was remarkable in that the onset of the decrease at McMurdo, in the Antarctic, was one day earlier than at Thule, in the Arctic. The north–south asymmetry persisted for about four days, and its maximum magnitude was approximately 2.5%. (auth)

34100 COSMIC-RAY INTENSITY DISTRIBUTION OVER THE TERRITORY OF THE USSR, THE LATITUDE EFFECT, AND COUPLING COEFFICIENTS OF THE COSMIC RAY MUON COMPONENT AT SEA LEVEL. Dorman, L. I. (IZMIRAN, Moscow); Kovalenko, V. A.; Milovidova, N. P.; Chernov, S. B. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 359-63(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Using experimental data of three cosmic-ray expeditions on the territory of USSR carried out during the period of low solar activity (1964–1966), the lines of equal cosmic-ray intensities were determined and compared with the theoretically predicted distribution of cut-off rigidities as given by Quenby and Wenk, Makino, Kondo and Kodama, Shea, and Smart. The best agreement for the territory of USSR (except the region of the East-

Siberian geomagnetic anomaly) was found with the model of Shea and Smart. The results of measurements of the cosmic-ray latitude effect and the coupling coefficients are given. These measurements were carried out on m/s "Kislovodsk" during the period of December 1967–March 1968 on a voyage from Leningrad to Buenos Aires. (auth)

34101 INVESTIGATION OF ANISOTROPY IN SURROUNDING A SHOCK-WAVE FRONT. Altukhov, A. M.; Mamrukova, V. P.; Shafer, G. V. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 365-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Cases of cosmic-ray intensity decrease connected with the arrival at the Earth of shock waves are considered. In some cases the anisotropy is directed approximately along the interplanetary magnetic field before the beginning of the decrease. During the period of the decrease, the direction of the anisotropy corresponds to midday or evening hours of local time. The dependence of the anisotropy on the heliolongitude of the chromosphere event is discussed. (auth)

34102 SOME ASPECTS OF THE INTERACTION OF THE SOLAR WIND WITH THE INTERSTELLAR MEDIUM. Salimzibarov, R. B.; Shafer, Yu. G. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 369-71(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The production of a stationary shock wave in the shell dividing the regions of solar wind and interstellar medium is assumed, and the effects of such a stationary shock wave upon the primary cosmic radiation are investigated in detail. (auth)

34103 SOLAR AND GALACTIC COSMIC RAYS AND THE INTERPLANETARY MAGNETIC FIELD, JANUARY 28–FEBRUARY 28, 1967. Lindgren, S. (Uppsala Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 401-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Solar and galactic particle fluxes after the January 28, 1967 particle flare are discussed in relation to interplanetary field observations. A soft pre-event began at 0214 on January 28. It showed modulation features carried by the solar wind from Explorer 33, 67 R_E upstream, to IMP-3, 15 R_E downstream from the Earth. The interplanetary magnetic field showed a sudden, major change of direction in coincidence with the onset of the main event, which began at 0835. New injections of energetic protons took place late on February 2 and 13. The enhanced diurnal variation seen by neutron monitors January 31–February 7 coincided well with a twofold increase in the magnitude of the interplanetary magnetic field. Several hours before a magnetic storm at the end of this period, the interplanetary magnetic field appeared to be strongly squeezed; it entered the ecliptic plane from below at a Θ-angle of 60° and with a magnitude of 10 gammas. (auth)

34104 COSMIC-RAY SOLAR FLARE INCREASE OF NOVEMBER 18, 1968. Tanskanen, P. J. (Univ. of Oulu, Finland). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 421-5(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The solar proton event of November 18, 1968 was studied using data from neutron monitors. The event was very anisotropic with maximum intensity in the "garden hose" direction and the rise time was about 0.5 hr from the onset of the optical flare. (auth)

34105 SOLAR-FLARE INCREASES IN COSMIC-RAY INTENSITY OBSERVED AT SULPHUR MOUNTAIN AND CALGARY BETWEEN NOVEMBER 1968 AND APRIL 1969. Mathews, T.; Wilson, B. G. (Univ. of Calgary, Alberta). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 433-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Increases in cosmic-ray intensity associated with solar flares were observed on November 18, 1968, February 25, 1969, and March 30, 1969 at Sulphur Mountain and Calgary. These increases, though small, showed considerable differences among themselves, the first two events being anisotropic during the onset phase and the last isotropic. A preliminary study of these flare increases shows that they were very similar to those observed on May 4, 1960, November 15, 1960, and January 28, 1967, respectively. (auth)

34106 PROPAGATION OF SOLAR AND GALACTIC COSMIC RAYS OF LOW ENERGIES IN THE INTERPLANETARY MEDIUM. Vernov, S. N.; Chudakov, A. E.; Vakulov, P. V.; (and others) (Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 459-69(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The results of measurements of low-energy cosmic rays from Zond-3, Venus-2, Venus-3, and Venus-4 space probes for the period from 1965 to 1967 as well as preliminary results from Venus-5 and Venus-6 space probes are summarized. It is shown on the basis of solar cosmic-ray bursts and Forbush decreases of galactic cosmic rays that solar cosmic rays propagate rapidly from the ejection region near the Sun along the beam of magnetic lines of force emerging from the active region on the Sun, and slowly when they are retarded in the region of the field knee created by the shock wave from the burst and move together with the knee at the velocity of the wave. It is shown that the observed retardation of shock waves from the bursts results in the disappearance of Forbush decreases and an accumulation of solar cosmic rays at a distance of ≈ 2 AU from the Sun. It is shown from the observations of variations in galactic cosmic rays that the variation parameters (amplitude, steepness of fall) are determined by the dynamics, latitude, and development phase of active regions. (auth)

34107 GEOMAGNETIC CUTOFF AT FT. CHURCHILL AND THE PRIMARY COSMIC-RAY ELECTRON SPECTRUM FROM 10 MeV TO 12 GeV IN 1968. Hovestadt, D.; Meyer, P. (Univ. of Chicago). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 525-31 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The energy spectrum of cosmic-ray electrons was measured at Ft. Churchill in 1968 with a counter telescope of high-energy resolution and discrimination against nuclear particles. The instrument had a geometrical factor of about 18 cm^2 sr which enabled one to investigate short-term temporal intensity variations with good statistical accuracy. The daily variation of the geomagnetic cut-off at Ft. Churchill (invariant latitude ≈ 70°) was studied by measuring the local time dependence of re-entrant albedo electrons. The transition from low to high cut-off was observed to begin around 0300 local time, with the time dependence of the transition depending on energy. A daytime cut-off at Ft. Churchill between 170 and 250 MV and a nighttime cut-off below 12 MV were found. (auth)

34108 APPLICATION OF TRAJECTORY-DERIVED CUTOFF RIGIDITIES TO COSMIC-RAY INTENSITY VARIATIONS. Shea, M. A.; Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 533-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The results of applying trajectory-derived cutoff rigidities to experimental data have delineated three areas where caution must be exercised: (1) Solar cosmic rays — A change in the spectral slope of incoming radiation will not significantly change the effective cutoff rigidity of a neutron monitor; (2) Non-zenith effects — The effect over zenith angles of significant contribution must be evaluated to obtain an effective cutoff rigidity; (3) Daily variation — A small daily variation in the vertical cutoff rigidity due to the asymmetric configuration of the magnetosphere will result in changes in the counting rate of a sea level neutron monitor (located where the vertical cutoff rigidity is approximately 2 GV) of the order of 0.15%. (auth)

34109 TIME DEPENDENCE OF POSITION OF THE COSMIC-RAY EQUATOR. Sporre, B. (Uppsala Univ.); Pomerantz, M. A. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 545-51(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

In order to determine whether the position of the cosmic-ray equator is dependent upon the level of solar activity, observations were obtained with a shipborne neutron monitor during IGY and IQSY. Twelve equatorial crossings were made at 14°W, and four at 60°E. Comparison of the two groups of measurements representing a high level of solar activity (1956–1959) and solar minimum (1964) reveals a small northward shift in the equator off the west coast of Africa (14°W: 6.7° ± 0.4°N to 8.2° ± 0.6°N) between the first and second periods. On the other hand, the position in the Indian Ocean remained fixed (60°E: 6.1° ± 0.3°N). This effect could be attributable to the secular variation of the geomagnetic field. Calculations of vertical trajectories by Shea and Smart (1966) utilizing Finch and Leaton (1957) field coefficients for the epochs 1955 and 1964 lead to equator positions 6.75 ± 0.08°N (1955) and 7.02 ± 0.08°N (1964) at 14°W, and 6.62 ± 0.12°N (1955) and 6.60 ± 0.12°N (1964) at 60°E. Available evidence indicates that the difference between the calculated and observed shifts at 14°W cannot be ascribed to the contributions of trajectories from inclined directions. An alternative hypothesis is that the shift has its origin in external sources. This possibility cannot be ruled out by the available evidence. (auth)

34110 LATITUDE DISTRIBUTIONS OF COSMIC-RAY COMPONENTS AT SEA LEVEL AND AT AIRPLANE ALTITUDES IN THE SOUTH AFRICAN MAGNETIC ANOMALY. van der Walt, A. J.; Stoker, P. H.; Maree, J. P.; Coetzee, W. F. (Potchefstroom Univ., S. Afr.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 553-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Latitude surveys en route to Syowa Base, Antarctica from 1956 to 1962 showed a latitude knee at an unusual high cutoff rigidity during 1956/57, which developed into a double knee during later surveys. Shipboard neutron monitor observations conducted by the Potchefstroom group from 1962 to 1968 in the region of the South African Magnetic Anomaly show normal latitude curves depending on the phase of the solar activity cycle when plotted against cutoff rigidities calculated from particle trajectory integrations. The latitude dependence of the cosmic-ray nucleonic and soft components were also obtained during airplane flights in 1962, 1964, and 1966. These distributions are compared with northern hemisphere distributions. (auth)

34111 CUTOFF RIGIDITIES AND LATITUDE DEPENDENCE OF MUONS AT 307 g/cm^2 IN INCLINED DIRECTIONS. Coetzee, W. F.; Koenig, P. J.; Maree, J. P.; (and others) (Potchefstroom Univ., S. Afr.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 559-63(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A four directional inclined and vertical telescope were flown in the region of the Capetown Magnetic Anomaly region at 307 g/cm^2 atmospheric depth. Within the scattering of the measured intensities a consistent intensity distribution with cutoff rigidity was obtained for 45° zenith and magnetic east, south, west, and north azimuths. (auth)

34112 TIME VARIATIONS OF MULTIPLE NEUTRON INTENSITIES AT SYOWA STATION, ANTARCTICA. Ishida, Y. (Fukushima Univ., Japan); Kodama, M. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 565-70(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Multiplicity measurements in the NM-64 neutron monitor have been made continuously at Syowa Station, Antarctica, since March 1967. A preliminary report on statistical investigations of the six different multiplicities from $m = 1$ to $m \geq 6$ is given in connection with the Forbush decrease, diurnal variation, solar protons, and storm time increase. The availability and limitations of multiplicity work are discussed. (auth)

34113 DIFFERENTIAL RIGIDITY RESPONSE OF DIFFERENT MULTIPLICITIES IN THE NM-64 NEUTRON MONITOR. Kodama, M.; Inoue, A. (Inst. of Physical and Chemical Research, Tokyo). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 577-81(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

To obtain the differential response of different multiplicities in the NM-64 neutron monitor as a function of rigidities, three latitude surveys using a shipborne 3-NM-64 neutron monitor were carried out over the range of threshold rigidity 0.4 to 17.6 GV during 1966–1968. On the basis of data from these surveys, the differential response curves for six different multiplicities from $m = 1$ to $m \geq 6$ are presented for each survey. Corrections for both a finite gating time and overlapping events are taken into account. Discussions of rigidity dependence on the barometric coefficients are described in comparison with the coefficients from some other cosmic-ray stations. (auth)

34114 CALCULATION OF THE MULTIPLICITY YIELD FUNCTION OF NEUTRON MONITORS. Debrunner, H.; Flueckiger, E. (Univ., Bern). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 583-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An attempt is being made to calculate the multiplicity yield function of neutron monitors. The present paper reports the calculation method and includes preliminary results. (auth)

34115 SIMULATION OF COSMIC-RAY VARIATION DUE TO TEMPERATURE EFFECT. Miyazaki, Y.; Wada, M. (Inst. of Physical and Chemical Research, Tokyo). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 591-5(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Variations of meson intensity corresponding to atmospheric temperature variations are simulated from temperatures reported by an ordinary radiosonde observatory. Dorman's partial temperature coefficients are employed for constructing the variations of three meson components. The components are slow (meson of energies between 0.2 and 0.35 GeV), cubic (mesons observable by the cubic meson telescope), and underground (mesons at 55 mwe). The temperature at the respective isobaric level is related to the three simulated components. The multiple correlation coefficient thus obtained indicates that the temperature can be estimated from the three cosmic-ray components within an uncertainty of one or two degrees. This means that there is a possibility of continuous monitoring of the atmospheric temperature variations at several isobaric levels by means of cosmic-ray detectors on the ground. (auth)

34116 MULTIPLICITY MEASUREMENTS AT AHMEDABAD. Agrawal, S. P.; Ray, S. K.; Rao, U. R. (Physical Research Lab., Ahmedabad, India). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 597-600(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An 18 NM-64 Super Neutron Monitor at Ahmedabad (cut-off rigidity 16 GV) having a count rate of about 0.2 million per hour, commenced operation from August 1968. A neutron multiplicity meter was attached to the monitor to investigate the energy spectrum of the time variation of cosmic radiation in great detail. The results indicated a much larger percentage of high multiplicity neutrons as compared with the high multiplicity events at middle and high-latitude stations. The barometric coefficient of the neutrons of different multiplicities were evaluated and compared with earlier results. (auth)

34117 ISORIGIDITY CONTOURS IN POLAR REGIONS INTERPOLATED FROM TRAJECTORY-DERIVED VERTICAL CUTOFF RIGIDITIES. Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.); Shea, M. A.; Gall, Ruth. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 601-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Trajectory-derived vertical cutoff rigidities were calculated along a specific geographic meridian using a magnetospheric model. The mathematical representation of the geomagnetic field included a high simulation of the internal field plus the external sources in the tail and the magnetopause. The vertical cutoff rigidities which were determined by the method of tracing cosmic-ray trajectories through this model had a daily variation with the midnight value approaching zero at invariant latitude of approximately 69° and the noon cutoff approaching zero at invariant latitude of about 75°. Using the invariant latitude of the internal field as an interpolation aid, iso-rigidity contours were derived at various local times for the polar regions. (auth)

34118 INVESTIGATION OF BAROMETER EFFECT OF THE COSMIC-RAY NEUTRON COMPONENT. Alaniya, M. V.; Rogava, O. G.; Shatashvili, L. K. (Inst. of Geophysics, Tbilisi, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 605-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A latitude effect of 18 to 20% of the barometer coefficient of the cosmic-ray neutron component was observed during the period of minimum solar activity, i.e. the barometer coefficient decreases by ≈1.5 to 3.0% if the mean cosmic-ray rigidity increases by 1 to 2 GV. On the basis of the data of the stations Ottawa and Churchill for the period of 1957–1964 it has been shown that 11 year variations of the barometer coefficient must be of the order of 6 to 7%. The expected effect of μ mesons and radioactivity upon the barometer effect was estimated. (auth)

34119 LATITUDE KNEE OF SECONDARY COSMIC RAYS. Allkofer, O. C.; Dau, W. D. (Univ., Kiel). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 611-18(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Theoretical calculations are presented for the latitude knee of secondary cosmic rays. It is pointed out that two latitude knees exist at different positions; one for the nucleonic and one for the muon component. The existence of the latitude knee is caused by the influence of the geomagnetic field on the primary particles. The exact position of the knee, however, in the case of the nucleonic component is due to the flattening in the integral primary spectrum in the low-energy region. Concerning the latitude knee of the muon component the position is determined by the minimum primary energy for the production of relevant muons as well as by the ionization loss of the muons in the atmosphere. The behavior of the latitude knee is calculated in dependence of the particle's energy and atmospheric depth. The results are compared with experimental facts. (auth)

34120 EFFECTS OF THE ATMOSPHERE AND SNOW ON THE COUNTING RATE OF THE SANAE NEUTRON MONITOR. Kuehn, G. J.; Maree, J. P.; Stoker, P. H.; van der Walt, A. J. (Potchefstroom Univ., S. Afr.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 619-25(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The counting rate of the 3-NM-64 neutron monitor at Sanae, Antarctica, is not affected by the rising snow level, presumably due to the $5\frac{1}{2}$ inch paraffin wax layer placed underneath and along the sides of the monitor. The barometric pressure coefficient is varying as may be expected for a Chalk River neutron monitor over the years 1964 to 1967. The seasonal variation in the pressure corrected counting rate of the monitor is due to a seasonal variation in the atmospheric temperature. A temperature correction factor, $C_T = 5$, was obtained for monthly averages, while $C_T = 1.4 \pm 0.4$ for 1964 on daily averages. The atmosphere appeared to be heated when some selected riometer absorption events occur, causing a decrease in counting rate of 0.5% on the average. (auth)

34121 INFLUENCE OF SNOW AND WATER ON THE DIFFERENT MULTIPLICITIES AS OBSERVED IN A NEUTRON MONITOR NM-64 IN OULU. Blomster, K. A.; Tanskanen, P. J. (Univ. of Oulu, Finland). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 627-30(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The influence of snow and water on the over-all counting rate as well as on the counting rates of events of multiplicities $m = 1, 2, 3 + 4$, and ≥ 5 were investigated. It was found that up to a water thickness of 9 g/cm^2 the changes of the counting rates appear as linear functions of the water thickness, though with different slopes. Similar measurements were also made with snow. (auth)

34122 MULTIPLICITY MEASUREMENTS. Kapustin, I. N.; Radkevich, V. A.; Ustinovich, V. T. (Polar Geophysical Inst., Apatity, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 631-3(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The influence of random coincidences on different multiplicities is discussed. This effect leads to changes in the amplitude of the true variations. An estimation of the distortion of the barometer coefficient due to the random coincidences is given. (auth)

34123 THRESHOLD RIGIDITIES AND COUPLING CONSTANTS OF A NEUTRON SUPERMONITOR AND A MULTIPLICITY METER. Smirnov, V. S.; Ustinovich, V. T. (Polar Geophysical Inst., Apatity, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 635-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The efficiencies of three models (Quenby and Wenk, Makino, and trajectory computer threshold rigidities) were investigated by a comparison of the theoretical and experimental data. The best (trajectory computed threshold rigidity) was used to determine the coupling constants of a supermonitor and a multiplicity meter. (auth)

34124 DIURNAL VARIATION OF THE HIGH-ENERGY μ-MESON FLUX IN CONNECTION WITH LUNAR TIME. Mabboux, C.; Mabboux-Tariel, G. (Univ., Caen, France). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 639-42(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A rigorous statistical treatment of the shot-by-shot method is presented using properties of the Fourier transform. Analysis of events detected at a depth of 500 meters underground in the iron mine of Caen shows unambiguously a modulation effect in phase with the crossing time of the Moon at the meridian and the maximum of the flux appears at moon-rise. An attempt is made to interpret this effect in terms of an atmospheric tide of high-altitude layers where π mesons are created. (auth)

34125 MOMENTUM SPECTRA AND CHARGE RATIO AT 60^0 IN THE EAST–WEST PLANE. Allkofer, O. C.; Clausen, K. (Univ., Kiel). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 689-96 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The momentum spectra of muons arriving at zenith angles of 0° and 60° in the east–west plane were determined in the momentum range 0.2 to 30 GeV/c using a spark chamber spectrograph. The sea level spectra were calculated as a function of zenith angle in this momentum range. The significant modification of charge ratio at 60° in east and west direction due to geomagnetic deflection could be explained by a theory based on calculated inclined spectra. (auth)

34126 ENERGETIC NEUTRONS AND GAMMA RAYS AT BALLOON ALTITUDE OVER EQUATORIAL LATITUDE. Daniel, R. R.; Gokhale, G. S.; Joseph, G.; Lavakare, P. J. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 697-702(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Using the Pulse Shape Discrimination technique in a CsI(Tl) crystal, the flux of energetic neutrons ($10 \leq E \leq 500$ MeV) at balloon altitudes was measured near the geomagnetic equator. Simultaneous observations on the gamma-ray component ($4 \lesssim E \lesssim 20$ MeV) are also reported. The extrapolation of the observed energetic neutron flux to the top of the atmosphere gave a value of $(2.0 \pm 0.5) \times 10^{-2}$ neutrons $cm^{-2}\ sec^{-1}$ for the cosmic-ray neutron leakage flux. The implications of these new results on the origin of the Earth's radiation belt are discussed briefly. Measurements made during a solar flare of importance 1B which occurred during the flight were used to give an upper limit of $\approx 1.2 \times 10^{-2}$ neutrons $cm^{-2}\ sec^{-1}$ for the flux of solar neutrons of energy $50 \leq E \leq 500$ MeV from this flare. (auth)

34127 ENERGY SPECTRUM OF FAST NEUTRONS IN THE ATMOSPHERE. Lockwood, J. A.; St. Onge, R. N.; Klumpar, D.; Schow, D. (Univ. of New Hampshire, Durham). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 703-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The energy spectrum of fast neutrons (3 to 17 MeV) in the atmosphere was measured at geomagnetic latitude 42°N ($P_c = 4.4$ GV). The $n-\gamma$ detector, enclosed in an anticoincidence charged particle shield, was a 5 × 5 cm diameter cell of organic liquid scintillator (NE213) coupled to a high-resolution, two-parameter, multiparticle pulse-shape discriminator (PSD) with a two-parameter (64 × 64) logarithmic pulse-height analyzer. At 5.5 g/cm^2 the slope of the differential neutron energy spectrum given by $dN/dE = BE^{-\beta(E)}$ was 2.0 ± 0.15 between 3.5 and 7.0 MeV and 1.0 ± 0.15 in the range 7 to 17 MeV. (auth)

34128 ALTITUDE VARIATION OF HIGH-ENERGY NEUTRONS NEAR TOP OF THE ATMOSPHERE. Zych, A. D.; Frye, G. M. Jr. (Case Western Reserve Univ., Cleveland). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 709-14(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The variation in counting rate with atmospheric depth over the range from 3.3 to 102 g/cm^2 for high-energy neutrons from 12 to 100 MeV is presented. This result was obtained on a balloon flight from Palestine, Texas (USA) on July 24, 1968. During this flight, helium was valved from the top of the balloon to permit a controlled descent. Data were obtained at the selected altitudes during the descent. The high-energy neutron counting rate was observed to be an exponential function of atmospheric depth for depths less than about 20 g/cm^2. The detector, which was a spark chamber with polyethylene plates, was flown with its axis of symmetry at an angle of 45° with the downward direction. With this orientation, the horizontal and vertical components of the albedo neutron flux were observed to be the same at 102 g/cm^2 but near the top of the atmosphere the horizon component was enhanced. (auth)

34129 BAROMETER EFFECT OF COSMIC RAYS AND CHANGES OF THE ENERGY SPECTRUM AND CUTOFF RIGIDITIES. THE METHOD OF THE PARTIAL BAROMETER COEFFICIENTS. Dorman, L. I. (IZMIRAN, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 715-19(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The barometer coefficient of integral multiplicity for the cosmic-ray secondary component is determined. It has been shown that using this coefficient it is easy to take into account the influence of the change in the primary energy and in the cut-off rigidity on the barometer effect. The partial barometer coefficient for the cosmic-ray neutron component is estimated. (auth)

34130 ENERGY SPECTRUM OF FAST NEUTRONS IN THE UPPER ATMOSPHERE USING RECOIL-PROTON TECHNIQUE IN NUCLEAR EMULSION. Bhatt, V. L.; Parikh, V. R. (Physical Research Lab., Ahmedabad, India). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 721-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Nuclear emulsion plates, Ilford G-5, of thickness 860 and 750 microns were exposed at ceiling heights of 4 and 6 mb of air at Hyderabad ($\lambda = 8°$N) in March 1965 and 1966. Single tracks originating within the emulsion due to elastic collisions of neutrons with free protons were looked for. The average energy (E) of neutrons responsible for recoil protons of energy E_p was calculated and a neutron spectrum in the energy range of 5.5 to 22 MeV was evaluated. The experimental results are compared with theoretical calculations and values obtained by other workers. (auth)

34131 ATMOSPHERIC ELECTRON SPECTRUM OVER HYDERABAD AND A STUDY OF RE-ENTRANT ALBEDO ELECTRONS. Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 727-32 (1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An attempt has been made to derive the pion production spectrum from the observed γ-ray spectrum over Hyderabad, India where the vertical geomagnetic threshold energy is 16.9 GV. Using this information the energy spectrum of the atmospheric electrons was deduced and a comparison made with the observed spectrum over the same latitude, from which an upper limit to the flux of re-entrant albedo electrons was obtained. A qualitative study was made on the characteristics of the re-entrant electron spectrum; also a method for determining the energy spectrum of re-entrant electrons over any latitude is described. (auth)

34132 ENERGY SPECTRUM OF ATMOSPHERIC GAMMA RAYS AND ITS IMPLICATION ON THE CHARACTERISTICS OF HIGH-ENERGY INTERACTIONS. Stephens, S. A. (Tata Inst. of Fundamental Research, Bombay). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 733-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Using a stack of hypersensitized nuclear emulsions which was exposed over Hyderabad, India at 10.2 g cm^{-2} of atmospheric depth, γ rays of energy >1 GeV, recorded during the time the stack was at the ceiling altitude, were studied. It was found that the observed differential energy spectrum can be represented by two power law spectra with the same spectral index $\beta \approx 2.6$; the one at energies >30 GeV had an absolute intensity about 3 times that at lower energies. From a detailed discussion on the possible sources of error, it was felt that it would be difficult to account for such an enhancement by a factor three as due to systematic errors associated with the measurements. For this reason and because of the similarity in the spectral shapes of the observed gamma rays and the nucleonic components of cosmic radiation, the observed effect was attributed to a possible change in the characteristics of high-energy interactions at energies $\gtrsim$ a few hundred GeV. In order to account for the enhancement of γ intensity at energies >30 GeV, without making any conflict with the observed muon spectrum, it is suggested that η°-mesons could be copiously produced from transitions of high isobaric states which are created at these energies. (auth)

34133 FLUX OF FAST NEUTRONS IN THE ATMOSPHERE. 1. THE EFFECT OF SOLAR MODULATION OF GALACTIC COSMIC RAYS. Merker, M.; Light, E. S.; Mendell, R. B.; Korff, S. A. (New York Univ., N. Y.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 739-44(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The effect of time-variations in galactic cosmic rays on the rate of production of neutrons in the atmosphere was studied. The experimental basis of the study was a series of balloon and airplane observations of the flux and spectrum of 1 to 10-MeV neutrons, in flights at high geomagnetic latitude, during the period of increasing solar modulation, 1965–1969. It also included latitude surveys in 1964–1965 and in 1968. A regression analysis was made of the neutron flux at the transition maximum vs. the counting rate of the Deep River neutron monitor. There was good correlation for periods when satellites and space probes indicated no increase in >20 MeV protons from solar flares. The theoretical basis of the study was a Monte Carlo calculation of neutron production and transport in the atmosphere. The incident primary spectrum used in the analysis was based on the solar modulated spectra measured in satellites, space probes, and neutron monitors. Further applications of the results are discussed. (auth)

34134 FLUX OF FAST NEUTRONS IN THE ATMOSPHERE. 2. SOLAR FLARE EFFECTS. Light, E. S.; Merker, M.; Mendell, R. B.; Korff, S. A. (New York Univ., N. Y.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 745-51(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Neutron production in the atmosphere during solar events is discussed, with particular reference to solar proton events and Forbush decreases. The basis of the analysis is data obtained with the fast neutron detector referred to in the previous paper. The detector was flown in airplanes at high latitude and at altitudes around the transition maximum for neutrons. The results of measurements are discussed in terms of a transport calculation based on the spectrum of flare particles incident on the atmosphere. (auth)

34135 IONIZATION AND GAMMA-RAY-FLUX MEASUREMENTS OVER HYDERABAD. Kasturirangan, K.; Bhavsar, P. D.; Nerurkar, N. W. (Physical Research Lab., Ahmedabad, India). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 753-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Measurements made over Hyderabad, India, of the 135 to 1120 keV gamma-ray flux in the atmosphere to a depth of 6 g cm^{-2} are presented. The twelve channel 5.1 × 5.1 cm NaI(Tl) spectrometer used was capable of resolving the 0.51 MeV annihilation line, and a flux of 0.066 ± 0.007 photons cm^{-2} sec^{-1} for this was observed at 6 g cm^{-2}. The results of the ionization rates measured with the continuous monitoring unit of the University of Minnesota flown from the same station in a number of balloon flights are also given. These rates together with the single GM counter rates were used to study latitude effect and other aspects of gamma radiation over this latitude. (auth)

34136 MEASUREMENT OF THE SPECTRA OF COSMIC-RAY ELECTRONS AND PHOTONS AT DIFFERENT ALTITUDES IN THE ATMOSPHERE. Bezus, V. A. (Inst. of Physical Engineering, Moscow); Galper, A. M.; Dmitrenko, V. V.; (and others). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 761-3(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The exponent of the energy spectrum of cosmic-ray electrons in the energy range 100 to 1500 MeV and photons in the energy range above 100 MeV was determined by means of a spark chamber flown by balloons at various altitudes. The exponent decreased from 2.7 ± 0.3 at sea level to 1.9 ± 0.2 at 150 g/cm^2 residual atmosphere, then increased to 2.9 ± 0.2 at 7 g/cm^2 residual atmosphere. The method of determining the exponent in question is discussed in detail. (auth)

34137 SOME ASPECTS OF THE GEOCHEMISTRY OF Ru, Os, Ir, AND Pt IN IRON METEORITES. Crocket, J. H. (McMaster Univ., Hamilton, Ont.). Geochim. Cosmochim. Acta; 36: No. 5, 517-35(May 1972).

Neutron-activation data for Ru, Os, and Ir in 46 iron meteorites and Pt and Au in 38 iron meteorites are reported. The suite was previously analysed for 12 other elements by Smales and co-workers (1967). All platinum group metals are positively correlated with each other except for Pd. Os, Ir, and Ru are highly correlated with each other whereas Pt is strongly correlated only with Ru. Pd was the only platinum group metal to correlate well with other non-platinum metals showing strong positive correlation with Ni, As, Au, Cu and Sb. There is a general positive correlation of Os, Ir, Ru, and Re within each of the chemical groups recognized by Wasson and co-workers (1967), but assignment of a meteorite to a specific chemical group from noble metal data alone is not possible. However, further division of chemical groups on a basis of Os–Ir–Re values may be possible. Suggested iron meteorite groupings according to Ir–Pt values are not supported by the data from this study. (auth)

34138 RADIATION AGES OF DIFFERENT FRAGMENTS OF THE SIKHOTE–ALIN METEORITE FALL. Kolesnikov, E. M.; Lavrukhina, A. K.; Fisenko, A. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geochim. Cosmochim. Acta; 36: No. 5, 573-6(May 1972).

Seven specimens from five different fragments of the Sikhote–Alin iron meteorite were analyzed for their content of ^{39}Ar, ^{38}Ar, ^{21}Ne, and ^{3}He. The ^{39}Ar–^{38}Ar-cosmic-ray exposure ages calculated from these data were $(450 \pm 20) \times 10^6$ yr for four of the fragments, that of one fragment was only $(145 \pm 11) \times 10^6$ yr. The discrepancy is explained as due to a collisional break-up of the meteorite less than approximately 150×10^6 yr ago. (auth)

Stars

Refer also to abstracts 34309, 34423, 34451, 34465, and 34466.

34139 PERIOD CHANGES IN THE W URSAE MAJORIS STAR XY LEO. Gehlich, U. K.; Proelss, J.; Wehmeyer, R. (Hamburger Sternwarte, Hamburg). Astron. Astrophys.; 18: No. 3, 477-80(May 1972).

The period changes of XY Leo were analyzed. An interpretation of these variations as a light time orbit implied that the third mass, if present, could be a white dwarf. Assuming sudden changes of the period ("jumps"), the observations could be represented by three periods. (auth)

34140 PHOTOMETIC OBSERVATIONS OF NOVA VULPECULAE 1968 n^0 1. Terzan, A. (Observatoire, Lyon). Astron. Astrophys.; 18: No. 3, 471-4(May 1972). (In French).

The light curve of Nova Vulpeculae 1968 is drawn for the period going from April 15, 1968 to December 12, 1970. The discussion of this light curve shows the nova to be a "rapid development" one; it is between 820 and 1300 pc away from the Sun, has entered its "nebular stage" about the beginning of June 1968 and since March 1970, and its brightness ($\cong$15.0) has been nearly constant. Four new variable stars near the nova are revealed. (auth)

34141 ROTATION OF EVOLVING A AND F STARS. Danziger, I. J.; Faber, S. M. (Harvard Coll. Observatory, Cambridge, Mass.). Astron. Astrophys.; 18: No. 3, 428-43(May 1972).

An analysis of stellar rotation among evolved stars of classes A and F is presented. It is shown that, within the framework of a number of specified assumptions, those stars that have expanded their radii by no more than a factor 2 appear to rotate as solid bodies. Stars of higher luminosity have rotational velocities that are more consistent with differential rotation, although the detailed form of this rotation cannot be elucidated from the observations. However, the results for luminosity class Ia stars are much less secure. An examination of relationships between rotation and pulsational instability in the δ Scuti star region suggests that low rotation is necessary to prevent inhibition of large pulsational amplitudes. In the A star region an as yet inexplicable correlation exists between rotation and metal abundance. (auth)

34142 EQUIVALENT WIDTH OF INTERSTELLAR MOLECULAR LINES. I. CO, SiO, H_2, AND CS IN THE INTERSTELLAR SPECTRUM OF ζ OPHIUCHI. Swamy, K. S. Krishna; Tarafdar, S. P. (Tata Inst. of Fundamental Research, Bombay). Astron. Astrophys.; 18: No. 3, 415-23(May 1972).

An analysis of the equivalent widths of the band system $(A^1\pi - X^1\Sigma^+)$ of the CO molecule was made using the observed equivalent widths of Smith and Stecher for the star ζ Ophiuchi. From the present study, upper limits for the various physical quantities of interest were obtained. It was also found that the population of the CO molecular lines are controlled by the radiation field of temperature ~3°K. The expected equivalent widths of the Lyman band of H_2 and $(A^1\pi - X^1\Sigma^+)$ bands of SiO and CS for ζ Ophiuchi were calculated and it was found that these lines should be detectable. (auth)

34143 NONRADIAL OSCILLATIONS AND VIBRATIONAL STABILITY OF A 0.5 $M_\odot$ STAR. Robe, H.; Ledoux, P.; Noels, A. (Institut d'Astrophysique, Cointe-Ougree, Belgium). Astron. Astrophys.; 18: No. 3, 424-7(May 1972).

The nonradial adiabatic oscillations and the vibrational stability of a 0.5-$M_\odot$ star, composed of a radiative core and an extended convective envelope were studied. It was found that despite the large relative amplitudes reached by the gravity modes in the core, a factor which should favor the destabilizing effects of the energy sources, this star remains vibrationally stable. This might not be the case however for more massive stars when, in their late evolution, they acquire extensive convective envelopes, a case which will be studied in the near future. (auth)

34144 OBSERVATIONS OF THE 3727 A [O II] DOUBLET IN THE ORION NEBULA. Caplan, J. G. (CNRS, Marseille). Astron. Astrophys.; 18: No. 3, 408-14(May 1972).

A procedure is described for reducing the photon-counting data obtained from Fabry–Perot scans of the density-sensitive [O II] doublet at 3727 Å in nebulae. Observations are presented for the Orion Nebula, obtained with a one-meter siderostat, with a 2′.1 exploring diaphragm. The ratio I (3729 Å)/I (3726 Å) increases rather symmetrically with distance from the Trapezium up to about 6′. At greater distances, the ratio increases most rapidly toward the south, less rapidly toward the west where much filamentary structure is present, and even less rapidly along the southeast region containing a long bright feature. Toward the north the ratio decreases in the vicinity of Messier 43. (auth)

34145 INTERACTION OF HOT STARS AND OF THE INTERSTELLAR MEDIUM. II. EXCITING STAR AND SPECTRA OF THE BRIGHT KNOT INSIDE THE DIFFUSE NEBULA SHARPLESS 157. Chopinet, M.; Lortet-Zuckermann, M. C. (Observatoire, Haute Provence, France. Observatoire, Bordeaux. Institut d'Astrophysique, Paris). Astron. Astrophys.; 18: No. 3, 373-81(May 1972).

The bright knot inside the diffuse nebula Sharpless 157 is probably excited mainly by its central star Sh 2–157–1, which has been found to be a late O type star. The knot has an inhomogeneous brightness distribution. Spectra with dispersion 300 and 400 Å/mm, obtained at the Observatorie de Haute Provence through an image-tube, show the ionization structure, a rather low degree of excitation, and emphasize the existence of a bar of high brightness. (auth)

34146 DOUBLE STARS OF EQUAL COMPONENTS. Stock, J.; Wroblewski, H. (Univ. of Chile, Santiago). Astron. Astrophys.; 18: No. 3, 341-9(May 1972).

A list of 271 double stars of nearly equal components with separations up to about one minute of arc is given. Their physical nature is demonstrated by their spectral-type distribution, which coincides with that of close double stars of equal components but differs from that of general field stars. (auth)

34147 EVOLUTION AND SECULAR STABILITY OF A 0.8 $M_\odot$ CARBON STAR. Noels, A. (Univ., Liege). Astron. Astrophys.; 18: No. 3, 350-62(May 1972).

The evolution of a 0.8 $M_\odot$ star composed initially of 50% of ^{12}C and 50% ^{16}O was computed by the Henyey method from the early phase of gravitational contraction to the final cooling toward the white dwarf stage. Neutrino losses were not taken into account. The secular stability was then studied numerically throughout the evolution. It was found: (1) that the eigenspectrum consists of both real and complex conjugate eigenvalues, the appearance of the latter being correlated with the existence of nuclear reactions in the core, and (2) that the real part of the eigenspectrum has always an upper bound. During its evolution, the star undergoes four unstable phases: (1) at the beginning of the gravitational contraction, (2) during the rise in temperature associated with the first carbon flash, (3) during the rise in temperature associated with the second carbon flash, and (4) during the "antiflash" corresponding to the complete disappearance of the nuclear reactions. Those phases are discussed. Moreover, the stability problem solved provides one with a system of eigenfunctions which is particularly convenient to represent the evolution of the star in a linear approximation. In most phases, this "linear" evolution shows an excellent agreement with the evolutionary results. (auth)

34148 OBSERVATIONAL TEST OF HYDROGEN LINE BROADENING THEORIES. Dufton, P. L. (Cambridge Univ., Eng.). Astron. Astrophys.; 18: No. 3, 335-40(May 1972).

A method is described of deducing the gravity of an early-type star from the strength of the forbidden neutral helium line at 4045.16 Å. For two helium-rich stars, HD 96446 and HD 168785, gravities log g = 4.0 are found. These are shown to be significantly smaller, by approximately a factor of three, than the gravities deduced using the hydrogen lines and the ESW Stark broadening theory. An extension of the method to early B-type stars with normal helium abundances and small rotational velocities is suggested. (auth)

34149 SPECTROPHOTOMETRIC STUDY OF THE ECLIPSING-VARIABLE SYSTEM AW PEG. Babaev, M. B. (Shemakhin Astrophysical Observatory, USSR). Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 1, 82-8(1971). (In Russian).

The spectral lines and atmospheric conditions were investigated for the stellar components of the eclipsing-variable AW Peg. A total of 43 spectrograms were made between May, 1967 and October 1968, and the equivalent line widths of absorption were determined for H_δ and H_γ of hydrogen. From the spectral data the electron pressure and density in the stellar atmospheres were computed. (K.S.W.)

34150 VARIABILITY OF EMISSION LINES OF WOLF–RAYET STARS. Gusein-Zade, A. A.; Babaev, M. B. (Shemakhin Astrophysical Observatory, USSR). Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 1, 79-81(1971). (In Russian).

The transient variation in emission lines of Wolf–Rayet stars from the year 1967 was studied, using a 35-cm telescope with an objective prism and photoelectric scanning. For the stars studied, catalog number, apparent stellar magnitude, and spectral index are given. It was concluded that the variations were random in nature, the line profile and the line wing changed independently, and variations in the short-wave and long-wave halves of the profile occurred independently. The variations could be detected in a 20-min observation. (K.S.W.)

34151 ADVANCES IN ASTRONOMY AND ASTROPHYSICS. VOLUME 9. Kopal, Zdenek (ed.). New York; Academic Press, Inc. (1972). 261p. $16.50.

A separate abstract was prepared for one of the four chapters. (W.D.M.)

For abstract of individual paper see: 34152.

34152 ROCHE MODEL AND ITS APPLICATIONS TO CLOSE BINARY SYSTEMS. Kopal, Zdenek (Univ. of Manchester, Eng.). Advan. Astron. Astrophys.; 9: 1-65(1972).

An attempt is made to give a comprehensive outline of the theory of the equipotential surfaces for fluid stars of arbitrary structure distorted by rotation or tides. The geometrical properties of the Roche equipotentials, and, in particular, of the limiting equipotentials (Roche limit) at which the respective configuration will cease to be able to contain its mass in a closed volume, are considered. Many problems concerning close binary systems are treated by the introduction of a system of "Roche curvilinear coordinates". The problem of vibrational stability of the Roche model is treated in the new Roche coordinates. (W.D.M.)

34153 EQ PEGASI: A DOUBLE FLARE STAR. Owen, F. N. (Univ. of Texas, Austin); Bopp, B. W.; Moffett, T. J.; Lazor, F. J. Astrophys. Lett.; 10: No. 1, 37-40(Jan 1972).

Simultaneous high-speed and area-scanning photometry show that the bright component of EQ Peg is a flare star. Additional simultaneous spectroscopy and high-speed photometry confirm that the faint component also flares. This finding refutes the common assumption that the fainter component of a flaring double star is always the flare star. (auth)

34154 UPPER MASS LIMIT FOR ISOLATED PULSARS. Hills, J. G. (Univ. of Michigan, Ann Arbor). Astrophys. Lett.; 10: No. 1, 27-30(Jan 1972).

An isolated neutron star having no energy sources except rotation cannot brake this rotation by the emission of either photons or cosmic-ray particles if it is more massive than about 1.7 $M_{\odot}$. Neutron stars less massive than this limit are likely to release much of their rotational energy by ejections of low-energy cosmic rays. (auth)

34155 NUCLEAR FORCES, COMPRESSIBILITY OF NEUTRON MATTER, AND THE MAXIMUM MASS OF NEUTRON STARS. Clark, J. W. (Institut fuer Theoretische Physik, Cologne); Heintzmann, H.; Hillebrandt, W.; Grewing, M. Astrophys. Lett.; 10: No. 1, 21-5(Jan 1972).

It is shown that if the published values of the MIT neutron-matter calculations are adopted at densities above 3×10^{14} g cm^{-3}, neutron-star models of about 0.8 $M_{\odot}$ can be obtained. If a solid-state model at high densities is adopted, even soft nuclear forces will lead to a maximum mass of 1.7 $M_{\odot}$ for stable neutron stars. (auth)

34156 NEW ANALYSIS OF THE ECLIPSING BINARY, U PEGASI. Rigterink, Paul V. (Univ. of Pennsylvania, Philadelphia). Astron. J.; 77: No. 4, 319-29(May 1972).

Photoelectric observations of U Pegasi in the B and V wavelength regions are presented. The light curves are compared with previous observations, and the changes in the light curve are noted. It is found that a large change occurred in the system between 1950 and 1958, but the light curve has remained constant since that time. New orbital elements are derived for the system using a slightly new rectification procedure. In addition, an analysis is made of the validity of the present and previous solutions. (auth)

34157 SPECTRAL CLASSIFICATION OF OB STARS IN BOTH HEMISPHERES AND THE ABSOLUTE-MAGNITUDE CALIBRATION. Walborn, Nolan R. (Univ. of Toronto). Astron. J.; 77: No. 4, 312-18(May 1972).

Some developments relating to the spectroscopic parallax system for the OB stars are described. New spectral-classification standards in the southern hemisphere are given and two-dimensional classifications for early O stars in both hemispheres are listed. An investigation of the absolute-magnitude calibration showed that the range of absolute magnitudes among the OB stars is greater than that derived in some previous calibrations. Finally, some new OB supergiants with anomalous nitrogen or carbon spectra were found. (auth)

34158 POLARIZATION OBSERVATIONS OF THE λ4430 DIFFUSE INTERSTELLAR ABSORPTION FEATURE. A'Hearn, Michael F. (Univ. of Maryland. College Park). Astron. J.; 77: No. 4, 302-5(May 1972).

Polarization observations were made of the diffuse interstellar absorption feature at λ4430 using filters to isolate the band and the neighboring continuum in five stars at various galactic longitudes. Results are much more accurate than previous investigations of this problem and indicate, contrary to some previous reports, that the feature is unpolarized. (auth)

34159 SEARCH FOR UV-BRIGHT STARS IN 27 GLOBULAR CLUSTERS. Zinn, R. J.; Newell, E. B.; Gibson, J. B. (Yale Univ., New Haven). Astron. Astrophys.; 18: No. 3, 390-402 (May 1972).

Twenty-seven globular clusters were searched for stars that lie to the left of the giant branch and above the horizontal branch in the HR-diagram. Stellar structure computations, by other authors, suggest that stars cross this region of the HR-diagram while evolving from the horizontal branch to the white dwarf stage. The results of the survey are presented in order to provide a finding list for future investigations of post-horizontal branch evolution. The stars of interest have brighter U magnitudes than any other cluster stars. This fact permitted their identification by a technique that involved blinking short-exposure U and V plates and suggested the name "UV-bright stars." Cluster membership has not yet been established for most of the UV-bright stars found in this survey. Nevertheless, the proximity of many of the stars to the cluster centers makes them likely candidates for membership. (auth)

34160 EXCHANGE CONTRIBUTION TO THE THERMODYNAMIC POTENTIAL OF A PARTIALLY DEGENERATE SEMIRELATIVISTIC ELECTRON GAS. Kovetz, A. (Univ. of Montreal); Lamb, D. Q.; Van Horn, H. M. Astrophys. J.; 174: No. 1, 109-20 (15 May 1972).

Asymptotic formulae were obtained for the exchange contribution to the thermodynamic potential of a partially degenerate, semirelativistic electron gas in the limits of weak degeneracy, strong degeneracy, and nonrelativistic degeneracy. The exchange integrals were evaluated numerically to an accuracy of a few tenths of a percent in the intermediate regime where the limiting approximations fail, and a table of the numerical results is given. The differences from the zero-temperature result of Zapolsky and Salpeter are not always negligible under stellar-interior conditions, especially for rather late evolutionary phases. (auth)

34161 LITHIUM-LIKE SPECTRA OF K XVII THROUGH Mn XXIII IN THE EXTREME-ULTRAVIOLET REGION. Goldsmith, S. (Tel-Aviv Univ., Israel); Feldman, U.; Oren, L.; Cohen, L. Astrophys. J.; 174: No. 1, 209-14(15 May 1972).

Identifications and classifications of spectral lines in the lithium-like spectra of the elements K through Mn are presented for the first time. The extrapolation procedures used to calculate these spectra are presented in detail. The excellent agreement between the predicted and measured lines establish the long-range extrapolation. (auth)

34162 SOME TRANSITIONS OF Ne VIII AND Ar VIII BETWEEN LEVELS OF PRINCIPAL QUANTUM NUMBERS 3, 4, AND 5. Druetta, M.; Datla, R. U.; Kunze, H.-J. (Univ. of Maryland, College Park). Astrophys. J.; 174: No. 1, 215-17 (15 May 1972).

Transitions of Ne VIII and Ar VIII between levels of principal quantum numbers 3, 4, and 5 were identified in a high-temperature plasma produced in a theta-pinch discharge. The transition probabilities for these lines were computed by using a method of A. Burgess. (auth)

34163 X-RAY EMISSSION FROM WHITE DWARFS. Strittmatter, P. A.; Brecher, K.; Burbidge, G. R. (Univ. of California, San Diego). Astrophys. J.; 174: No. 1, 91-9(15 May 1972).

It is suggested that both the 250-eV background radiation and the recently observed variations in the optical emission from certain white dwarfs may be due to thermal bremsstrahlung from hot coronae surrounding such stars. The x-ray flux from the variable white dwarfs is predicted and in the most favorable case, R548, is sufficiently large [I_X (3 keV) ~ 0.01 photons cm^{-2} s^{-1} keV^{-1}] to allow an observational test of the model. The possibility that the variations observed in strong x-ray sources are due to pulsations in the coronae surrounding degenerate stars, rather than in stars themselves, is also discussed. For the white dwarfs, both pulsation and rotation of the central star are found to be adequate sources of coronal energy, with pulsation being subject to relatively easy observational test. The energy requirements for the strong x-ray sources are briefly discussed. (auth)

34164 RATES FOR URCA NEUTRINO PROCESSES. Beaudet, G. (Univ. of Montreal); Salpeter, E. E.; Silvestro, M. L. Astrophys. J.; 174: No. 1, 79-90(15 May 1972).

Simple fitting formulae are presented for all types of allowed β-transitions (direct and $e^{\pm}$-capture) as functions of density ρ and temperature T. For a number of the most common stable even-even nuclei under equilibrium conditions, nuclear abundances and the overall rates of URCA energy loss are calculated as a function of ρ and T. For T ~ (1.5 to 5) × 10^9°K the URCA rates for these elements can dominate other neutrino processes, but only over fairly narrow density ranges at high densities. (auth)

34165 THERMODYNAMICS OF THE GRAY ATMOSPHERE. IV. ENTROPY TRANSFER AND PRODUCTION. Wildt, Rupert (Yale Univ., New Haven). Astrophys. J.; 174: No. 1, 69-77(15 May 1972).

In strict radiative equilibrium, i.e., if heat transport by conduction and convection is negligible, the local rate of entropy production must equal the divergence of the net flux of radiant entropy. Verification that this divergence is positive for LTE, is straightforward even in the nongray case. Entropy production throughout the interior can, in the absence of mass ejection, be disposed of only by the flux of radiant entropy escaping at the stellar surface, to which there is an (unattainable) upper limit depending solely on the effective temperature, namely, the entropy loss from the surface of an isothermal blackbody radiating at the same temperature. In effect, irrespective of grayness, the steady-state global rate of entropy production is bounded. (auth)

34166 CLASSIFICATION OF INTRINSIC VARIABLE STARS. I. THE RED VARIABLES OF TYPE N. Eggen, O. J. (Australian National Univ., Canberra). Astrophys. J.; 174: No. 1, 45-55(15 May 1972).

This is the first in a series of papers based on an examination of the classification system for intrinsic variables and concerns extensive (UBVRI) observations of the 35 N-type variables for which relatively accurate apparent motions are available. The N-type variables are found to be divided into all three population groups, (1) young disk (YD) objects such as the carbon stars in the Large Magellanic Cloud with $M_{bol} = -5$ mag (W and BL Ori and possibly Y Tau), (2) old disk (OD) population stars of mass near 1.25 $\mathfrak{M}_\odot$ and $M_{bol} = -3$ mag, such as the N-type member of NGC 2660 and the brighter component of the common-proper-motion pair HD 75021/2, and (3) the halo population, which consists of CH stars (V Ari and TT CVn) with M_{bol} near −3.5 mag. The ratio of these populations in the present sample is OD/YD/halo = 30/3/2. The old disk objects occur in a distinct break in the distribution along the giant branch, at R − I = +0.9 mag and almost certainly represent the first, and very transient, stage of instability. These stars occur at the luminosity where the ignition of the core helium halts the ascent of the giant branch in the theoretical evolutionary track of 1.25 $\mathfrak{M}_\odot$ stars. The young disk population objects at $M_{bol} = -5$ mag probably represent the largest (9 $\mathfrak{M}_\odot$) mass at which N-type stars are formed. No obvious spectroscopic differences appear between the young and old disk population stars, although the halo objects are characterized as CH stars. (auth)

34167 CONVERSION FACTOR FROM RADIAL TO PULSATIONAL VELOCITY AND THE RADII OF CLASSICAL CEPHEIDS. Parsons, Sidney B. (Case Western Reserve Univ., Cleveland). Astrophys. J.; 174: No. 1, 57-67(15 May 1972).

The conversion factor from observed radial velocity to the pulsational velocity of a stellar atmosphere, commonly adopted as $^{24}/_{17} = 1.41$, is found to be about 1.31 from actual calculations of line profiles appropriate to classical Cepheids. This 7% reduction still leaves the radii determined by Wesselink's method consistent for most Cepheids with the period−luminosity−color relation of Sandage and Tammann; for those with P > 15 days the Wesselink radii are smaller than expected. New radius determinations are presented and possible explanations of the discrepancy are discussed. (auth)

34168 OLD EVOLVED BINARY IN THE GALACTIC HALO. Young, Arthur; Nelson, Burt; Mielbrecht, Richard (San Diego State Coll., Calif.). Astrophys. J.; 174: No. 1, 27-31(15 May 1972).

The faint blue star HZ 22 is shown to be a very-short-period binary with properties that suggest it is highly evolved. It is probably more than 1500 pc above the galactic plane, and is either a very old disk Population I or a halo Population II star. (auth)

34169 PHOTOELECTRIC OBSERVATIONS OF THE MIRA VARIABLE S CARINAE. Wisse, P. N. J.; Wisse, M. (Republic Observatory, Johannesburg). Astron. Astrophys.; 19: No. 1, 164-6(Jun 1972).

New photoelectric observations of S Car are presented and compared with earlier results. It was found that the star is redder in both (B − V) and (U − B) when the light curve has a higher maximum, and also that in the same cases the maxima of the color curves occur at a later phase. S Car has tentatively been placed at a distance of 525 pc. (auth)

34170 MEMBERSHIP OF THE OPEN CLUSTER NGC 6819. Sanders, W. L. (Yerkes Observatory, Williams Bay, Wis. Kitt Peak National Observatory, Tucson, Ariz.). Astron. Astrophys.; 19: No. 1, 155-8(Jun 1972).

Probabilities of membership, based on relative proper motions, for 189 stars in the field of NGC 6819 are given. The cluster proper motion disperion (m.e.) of 0.0012 yields 88 probable members. (auth)

34171 SECULAR STABILITY OF PURE HELIUM STARS. Hansen, Carl J.; Cox, John P.; Herz, Margaret A. (Univ. of Colorado, Boulder). Astron. Astrophys.; 19: No. 1, 144-54 (Jun 1972).

Pure helium stellar models in complete equilibrium are analyzed for secular instabilities. With only one exception, all of the models, even the ones on the "high density" branch of the double-valued helium main sequence, are stable in the "fundamental" mode. The one exception is a model near the minimum mass of the sequence. Higher modes are also investigated, and are found to be stable in all cases. (auth)

34172 EVOLUTION OF A POPULATION I 8 $M_\odot$ STAR DURING CENTRAL HELIUM BURNING AND THE INFLUENCE OF THE COMPUTATIONAL TECHNIQUE. Noels, A.; Gabriel, M. (Univ., Liege). Astron. Astrophys.; 19: No. 1, 140-3(Jun 1972).

In order to test the sensitivity of the evolution during the central helium-burning phase, to the computational technique, the evolution of an 8-$M_\odot$ population I star was followed, using two schemes of difference for the discretization of the equation of energy conservation. It was found that the tracks in the H−R diagram were identical except near the "blue end" of the loops where the maximum values of the effective temperature differ only by 2%. (auth)

34173 PHOTOMETRY OF THE SUPERNOVA 1968 IN M 83. Wamsteker, Willem (Univ. of Arizona, Tucson). Astron. Astrophys.; 19: No. 1, 99-103(Jun 1972).

Photoelectric observations of the SN 1968 in M83 are presented. The observations are in the Walraven system. The supernova, which seems to be of Zwicky's Type I, had an absolute magnitude $M_v = -17.7$, corrected for foreground absorption. The observations cover a period of 62 days. The colors are very close to those of a black body. If this is the case, the supernova shows initially a drop in temperature. After this drop the temperature stays more or less constant for about 30 days. This interpretation makes it very difficult to explain the light curve. There seems to be enough evidence to make an interpretation in terms of synchrotron radiation plausible and more attractive. (auth)

34174 INFLUENCE OF THE EXCITED STATES OF TARGET NUCLEI IN THE VICINITY OF THE IRON PEAK ON STELLAR REACTION RATES. Arnould, M. (Univ. Libre, Brussels). Astron. Astrophys.; 19: No. 1, 92-8(Jun 1972).

With the aid of the statistical theory, the influence on the stellar reaction rates of the existence of rather heavy target nuclei in their various excited states is examined. From some specific examples, it is shown that the usual approximations commonly used to take such an effect into account sometimes fail to a great extent. This is particularly the case for endothermic reactions on targets possessing low-lying excited states from which the exit particle channels are greatly favored with respect to the ground state, due to restrictions imposed by spin conservation selection rules. (auth)

34175 PULSATIONAL INSTABILTY OF STARS DURING DEUTERIUM BURNING. Toma, E. (Univ., Liege). Astron. Astrophys.; 19: No. 1, 76-81(Jun 1972).

Pre-main-sequence evolutionary tracks for extreme Population I stars of 0.2, 0.6, 1.0, and 2.0 $M_\odot$ were calculated in order to study the effect of deuterium burning on pulsational stability. The initial abundance of deuterium was set equal to the abundance found in meteorites. The stability coefficient was calculated assuming that convection does not adapt to the pulsation. The vibrational instability manifests itself through the fundamental mode of radial oscillation and the pulsation amplitude will be multiplied in these stars by factors of 10^8 to 10^{15} at the end of the deuterium burning phase. An attempt is made to relate this result with T-Tauri-type stars in the young cluster NGC 2264. (auth)

34176 RELATION BETWEEN THERMAL DIFFUSION AND SECULAR TIME SCALES IN SIMPLE STELLAR ENVELOPES. Hansen, Carl J. (Univ. of Colorado, Boulder). Astron. Astrophys.; 19: No. 1, 71-5(Jun 1972).

Some simple calculations that indicate explicitly the relation between thermal diffusion times of photons in stellar envelopes and secular time scales are described. (auth)

34177 SHORT PERIOD VARIABLE STARS. IX. ROTATION AND MIXING IN THE OUTER LAYERS OF A STARS. TURBU-

LENT MIXING DUE TO THE MERIDIONAL CIRCULATION VELOCITY FIELD. Baglin, A. (Obervatoire, Nice). Astron. Astrophys.; 19: No. 1, 45-50(Jun 1972).

It is shown that mixing (or nonmixing) due to the meridional circulation velocity field associated with fast (or slow) rotation can explain most of the key observational properties of A stars (Breger, 1970). At present, it seems that the data are all consistent with the following scheme: slow rotators have abundance anomalies and are vibrationally stable, fast rotators are variable. When the equatorial velocity is smaller than 50 km/s abundance difference can develop and inhibit vibrational instability. When it is somewhat larger than 50 km/s turbulent mixing forces the star to remain homogeneous so that the helium content of the envelope is sufficient to drive the instability associated with the so-called "$\varkappa$ mechanism". (auth)

34178 . SECULAR STABILITY OF THE LOWER HYDROGEN-BURNING MAIN SEQUENCE. Stellingwerf, R. F.; Cox, J. P. (Univ. of Colorado, Boulder). Astron. Astrophys.; 19: No. 1, 8-12(Jun 1972).

The secular stability of the lower hydrogen-burning main sequence and its continuation—the high-density branch—is investigated using polytropic models modified to include the effects of ionization and photospheric boundary conditions. A form of "Jeans criterion" is derived for this case. It is shown that, for usual opacities, the high-density branch is secularly unstable, with the onset of instability coinciding with the minimum mass of the sequence. The effects of low-temperature opacity sources, such as grain formation, are found to have a strong stabilizing effect upon highly degenerate stars. (auth)

34179 UBV PHOTOGRAPHIC PHOTOMETRY OF STARS IN THE REGION AR_{1950} 17h03m–17h41m $DECL_{1950}$ -28.8^0 TO -33.4^0. III. THE CATALOGUE AND IDENTIFICATION MAPS OF OPEN STAR CLUSTERS: NGC 6405, NGC 6383, NGC 6374, Av 2, NGC 6416, AND H-ALPHA EMISSION REGIONS: GUM 67 (Av 3), GUM 68 (Av 2). Antalova, A. (Astronomical Inst., Skalnate Pleso, Czech.). Bull. Astron. Inst. Czech.; 23: No. 2, 126-39 (1972).

Drawing on the UBV photometry of the stars from the neighborhood of the star clusters mentioned, the problem of assigning stars to star clusters was treated. Two-color diagrams, identification maps, and catalogues of the measured stars are given. The probable variable stars are indicated following comparison of this photometry with the photometry of the stars carried out by other authors. The interstellar absorption was investigated in the regions mentioned as a function of distance. (auth)

34180 BINARY SYSTEMS AFTER RAPID MASS LOSS. Seidov, Z. F. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 23: No. 2, 123-5(1972).

The distribution of semi-major axes and eccentricities of binary systems after rapid mass losses is discussed. (auth)

34181 SUPERFLUIDITY IN NEUTRON STARS. Chanmugam, G.; O'Connell, R. F.; Rajagopal, A. K. (Louisiana State Univ., Baton Rouge). Phys. Lett.; 39A: No. 4, 285-6(22 May 1972).

Arguments are presented to show that the BCS theory of superfluidity in its original form may not be applicable to neutron star matter over a wide range of density. (auth)

34182 LIGHT TRACKS NEAR A DENSE CHARGED STAR. Burman, R. (Univ. of Western Australia, Nedlands). J. Proc. Roy. Soc. N. S. W.; 103: 87-90(1970).

Integrals of the Einstein–Maxwell equations for static spherically symmetric situations in regions outside matter, with one of the functions in the metric left arbitrary, were used to investigate light tracks in the presence of a charged body. Conditions for the existence of circular photon orbits were obtained and noncircular paths are discussed. (auth)

34183 ABUNDANCES AND IONIZATION STRUCTURE IN LOW-EXCITATION PLANETARY NEBULAE. Buerger, Edith Guderley. Columbus, Ohio; Ohio State Univ. (1971). 145p. University Microfilms Order No. 72-15,181.

Thesis.

Theoretical models giving the temperature and ionization distribution for a planetary nebula were constructed. The nebulae were idealized as spherical gas shells surrounding a hot central star. The gas consisted of H, He, C, N, O, Ne, S, Cl, and Ar and was assumed to be in a steady state. Inhomogeneities in the distribution of the gas were approximated by multiple densities existing simultaneously. The strengths of the forbidden lines based on these models were calculated. The three low-excitation nebulae IC 418, IC 4593, and IC 3568 were studied using these models. For each of the nebulae the parameters that specify the system were determined; the abundances that give the best fit to the observed line intensities were obtained. For the high excitation nebula NGC 7662, which had been studied previously, the sulfur, chlorine, and argon abundances were determined. Effects of uncertainties in the parameters that define the nebula were investigated to determine their importance. It was found that the stellar energy distribution is the most important parameter. The abundances determined in this way are based on fewer questionable assumptions and consequently are more reliable than those based on older methods. (Diss. Abstr. Int., B)

34184 PHYSICAL CONSEQUENCES OF GRAINS IN THE ATMOSPHERES OF LATE-TYPE IRREGULAR AND SEMIREGULAR GIANTS AND SUPERGIANTS. Jennings, Mark Crandall. Tucson, Ariz.; Univ. of Arizona (1972). 169p. University Microfilms Order No. 72-16,151.

Thesis.

The suggestion of an anticorrelation between Ca II H and K emission and observational indicators of grain material was investigated and seems confirmed. The H and K reversals and other heavy element emission lines, especially those of ionized species, tend to vanish in stars that exhibit intrinsic polarization and infrared excesses. The high incidence of Balmer emission among polarized stars is discussed, but it is not found to be a necessary condition for polarization, as has been previously suggested. It is argued that the disappearance of emission lines implies a weakening of the chromosphere usually associated with late stars and that grains are the primary agents responsible for the perturbation, either directly through cooling or by altering the density and temperature structure of the atmosphere by means of their dynamical effect. (TSS) (Diss. Abstr. Int., B)

34185 SHORT PERIOD LIGHT AND VELOCITY VARIATIONS IN ALPHA VIRGINIS. Shobbrook, R. R.; Lomb, N. R.; Herbison-Evans, D. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 165-80(1972).

The light variation of α Virginis (Spica) was followed over a total of 26 nights in 1968, 1969, and 1970. On seven nights in 1970, three-color observations were made. Both the 4-day variation with the orbital period and the 4-hr variation due to Beta Canis Majoris type pulsation (already reported) were evident; the amplitude of the short period appears to be randomly variable suggesting that the mode of pulsation is unstable. New spectra were obtained and the radial velocities discussed together with others published from 1890 to 1956. The 4-hr period was also found in part of this data but some of the earlier velocities indicated the presence of at least three more periodicities, including one of about 6 hr. It is suggested that the 4-hr period currently observed is only a first overtone pulsation and that the 6-hr period is the fundamental. The period of the 4-hr pulsation is variable although the form of the variation cannot be uniquely determined. The phase relationships between the light, color, and velocity variations during the 4-hr period were investigated and the temperature variation estimated. The phase relationships are the same as for other β CMa stars for which these parameters have been observed; that is, maximum light and temperature occur at, or very close to, minimum radius. (auth)

34186 TWO NEW BROAD-LINED BETA CANIS MAJORIS STARS. Shobbrook, R. R.; Lomb, N. R. (Univ. of Sydney). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 181-8(1972).

Light variations of small amplitude were detected in the two bright southern B stars λ and κ Scorpii, indicating that they are Beta Canis Majoris variables. In a Fourier analysis of the brightness variations of λ Sco the following periods were found: a fundamental period of 0.2137015d which has a range of 0.023 mag, the first harmonic of this period (range 0.0037 mag) and also a longer period of 10.15d (range 0.0079 mag). In addition, on one of the observing nights there appears to have been an eclipse of about 0.04 mag. For κ Sco the Fourier analysis yielded a main variation with a period of 0.19987d and a range of 0.009 mag, together with another short period of 0.20544d (range 0.0038 mag) and a longer period of 2.951d (range 0.0075 mag). The period of the beat between the two short periods is 2.50 ± 0.02 times longer than the 2.951d variation. (auth)

34187 EVOLUTIONARY ASPECTS OF THE CEPHEID STAGE. Fricke, K. J.; Strittmatter, P. A. (Univ., Goettingen, Ger.). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 129-50(1972).

Structural and evolutionary conditions that allow high-mass stars ($M > 4M_\odot$) to become Cepheid variables are examined. The important internal parameters for determining the location of stars in H–R diagram are isolated from computed sequences of static models. It is demonstrated that the existence of a (reasonably long lived) Cepheid phase depends largely on the composition profile near the shell source. The interplay of the various processes which take place during actual evolution is concisely expressed in a semi-empirical relation between effective temperature and core mass (or helium content in the core) for the static situation. A qualitative interpretation of the computed results is offered. For "extreme" Population I composition only stars with $4 \lesssim M/M_{\odot} \lesssim 7$ can spend a substantial time within the Cepheid instability region in the H–R diagram during post red-giant evolution. In the higher mass range, stars cross the Cepheid region very rapidly as a result of a secular instability which arises when a critical ratio between core and shell source luminosity is exceeded in the giant region. The existence of two branches of chemically identical solutions of the stellar structure equations— one stable, the other unstable— is demonstrated. (auth)

34188 GLOBULAR CLUSTER NGC 4833. Menzies, John (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 207-21(1972).

Photoelectrically calibrated photographic photometry of about 800 stars in NGC 4833 is presented. The color–magnitude and two-color diagrams suggest the cluster belongs to the extremely metal deficient class of globular clusters like M92. The ratio of giants to horizontal-branch stars is about unity suggesting a high helium abundance. The giant branch appears to have a gap at about the same magnitude relative to the horizontal branch as does M15. Eight new suspected variables were found. (auth)

34189 MODELS FOR FIVE W URSAE MAJORIS SYSTEMS. Mochnacki, S. W.; Doughty, N. A. (Univ. of Canterbury, Christchurch, New Zealand). Mon Notic. Roy. Astron. Soc.; 156: No. 2, 243-52(1972).

Assuming the Lucy model, the method of light curve synthesis was applied to derive common-envelope models for the totally eclipsing W Ursae Majoris systems: V566 Ophiuchi, RR Centauri, RZ Tauri, FG Hydrae, and DK Cygni. The applicability of the Lucy model is discussed. (auth)

34190 INFRARED RADIATION FROM RV TAURI STARS. Gehrz, Robert Douglas. Minneapolis; Univ. of Minnesota (1971). 142p. University Microfilms Order No. 72-14,300.
Thesis.

The discovery of anomalous infrared radiation in four RV Tauri stars by Gehrz and Woolf (Astrophys. J., 161: L213(1970)) led to a comprehensive infrared survey of RV Tauri stars and related objects. Broadband photometric measurements from 2.2 μ to 22 μ were made for 25 RV Tauri stars and 53 comparison stars. All 11 RV Tauri stars for which the [3.6]–[11.3] color could be measured have anomalous excess 11.3 μ radiation. Upper limits to the [3.6]–[11.3] color were set for 8 other RV Tauri stars, 6 of which may have large excess infrared radiation. The infrared data show that RV Tauri stars are embedded in extended cool dust thermospheres. Metallic silicates are the chief constituent of the dust in oxygen rich RV Tauri stars, while an unidentified material forms around carbon rich RV Tauri stars. Observations of yellow supergiants and intrinsic variables show that the RV Tauri stars are a unique infrared class. The average mass loss rate of 3×10^{-5} $M_{\odot}$/year per RV Tauri star is remarkably high, implying a lifetime of only 5×10^4 years. Optical polarization data for U Mon indicate a nonspherical photosphere (Serkowski, Astrophys. J., 160: 1107(1970)). The polarization of R Sct and U Mon is larger than would be expected for scattering by dust and it seems likely that a large component of the polarization in these stars is produced by Rayleigh scattering from neutral hydrogen. Infrared light curves were obtained for AC Her (2.2 μ, 3.6 μ, 11.3 μ, 18 μ), U Mon (2.2 μ, 3.6 μ, 11.3 μ), and RV Tau (3.6 μ, 4.8 μ, 11.3 μ). The infrared and visual variations are in phase. Combined optical and infrared data show that the photosphere is contracting perpendicular to the line of sight when the reversing layer is expanding along the line of sight. If this is due to a phase lag between photosphere and reversing layer, the lag is remarkably large. Energy balance between the dust thermosphere and the star at different phases requires radiation from a nonspherical photosphere. It is concluded that a strong nonradial pulsation is the most likely explanation of the observed peculiarities of RV Tauri stars. (Diss. Abstr. Int., B)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 34316.

34191 (CSIRO-Trans–10775) AGE OF PULSAR PSR 0833-45. Shklovskii, I. S. Translated by G. Losonci for Commonwealth Scientific and Industrial Research Organization, from Astron. Tsirk.; No. 519, 1-3(1969). 3p. Dep. NTIS (U. S. Sales Only).

An article substantially the same in content has appeared (Nature (London); 225: 252-3(Jan 17, 1970)), and was abstracted (see NSA 24: 12561). (Australia)

34192 DETECTION OF X-RAY POLARIZATION OF THE CRAB NEBULA. Novick, R.; Weisskopf, M. C.; Berthelsdorf, R.; Linke, R.; Wolff, R. S. (Columbia Univ., New York). Astrophys. J.; 174: No. 1, L1-8(15 May 1972).

Two different types of x-ray polarimeters were used in a sounding rocket to search for x-ray polarization of the Crab Nebula. Polarization was detected at a statistical confidence level of 99.7%. If the x-ray polarization is assumed to be independent of energy, the results of this and a previous experiment lead to a polarization of (15.4 ± 5.2)% at a position angle of 156° ± 10°. This result confirms the synchrotron model for x-ray emission from the Crab Nebula. (auth)

34193 DETECTION OF PULSED GAMMA RAYS OF $\sim 10^{12}$ eV FROM THE PULSAR IN THE CRAB NEBULA. Grindlay, J. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 174: No. 1, L9-17(15 May 1972).

The previous evidence given for the detection of pulsed γ rays of $\sim 10^{12}$ eV from NP 0532 was confirmed by an additional 99 drift scans on the Crab in November and December, 1971. Again, only those extensive air showers detected to be possibly initiated by γ rays showed a 4.5 σ excess at the phase of the optical interpulse. The sum of these data and those reported previously yielded a 5.5 σ peak at the interpulse and a 3.5 σ peak at the main pulse, consistent with a pulsed flux $F(E_{\gamma} \geq 6.8 \times 10^{11}\ \mathrm{eV}) \simeq 1.25 \times 10^{-11}$ photons $\mathrm{cm}^{-2}\ \mathrm{s}^{-1}$. The ratio of interpulse to primary pulse was ~3.5 : 1, and the spectrum appeared consistent with an extrapolation from the x-ray data. Some implications of these results are discussed. (auth)

34194 POLARIZATION OF THE CRAB PULSAR RADIATION AT LOW RADIO FREQUENCIES. Manchester, R. N.; Huguenin, G. R.; Taylor, J. H. (Univ. of Massachusetts, Amherst). Astrophys. J.; 174: No. 1, L19-23(15 May 1972).

Pulse shapes and linear polarization parameters for the Crab pulsar were determined at four frequencies between 110 and 160 MHz. The observations showed that the precursor component remains highly polarized at these frequencies, and that additional pulse components, not all polarized at the same position angle, are also present. (auth)

34195 EFFECT OF NEAR FIELDS ON THE PULSAR ACCELERATION OF PARTICLES. Kulsrud, Russell M. (Princeton Univ., N. J.). Astrophys. J.; 174: No. 1, L25-6 (15 May 1972).

It is pointed out that, if the near field is included in the calculation of the acceleration of particles from pulsars, then the electric field can be either larger or smaller than the magnetic field. This can lead to an appreciable increase in the amount of acceleration previously calculated from the radiation field alone if the phase is such that E exceeds B. In the opposite limit the acceleration produced, while unchanged, must occur at a larger radius. (auth)

34196 LIMITING MASS OF CENTAURUS X-3. Wilson, Robert E. (Univ. of South Florida, Tampa). Astrophys. J.; 174: No. 1, L27-30(15 May 1972).

A very low upper limit can be placed on the mass of Cen X-3, which was recently discovered to be a member of an x-ray eclipsing binary system. The principle used is that neither the eclipsing component itself nor any material that may orbit this component can exceed the primary Roche lobe, whose dimensions are determined by the mass ratio. A lower limit to the size of the Roche lobe follows from the observed duration of the x-ray eclipse. The photometric ellipticity effect offers a more promising means for optical identification than would radial-velocity observations, whose amplitude should not exceed about ±8 km s^{-1}. Predicted optical light curves are given for several mass ratios, including the effects of both geometric and photometric ellipticity. Constraints imposed by the mass limit on possible theoretical models for the x-ray source are briefly discussed. (auth)

34197 NEUTRON STAR IN CENTAURUS X-3. Sofia, Sabatino (Univ. of South Florida, Tampa). Astrophys. J.; 174: No. 1, L31-3(15 May 1972).

It is shown that the compact object producing the pulsed x radiation in the binary system Cen X-3 is probably a rotating neutron star of very low mass. (auth)

34198 SHOT-NOISE CHARACTER OF CYGNUS X-1 PULSATIONS. Terrell, N. James Jr. (Los Alamos Scientific Lab., N. Mex.). Astrophys. J.; 174: No. 1, L35-41(15 May 1972).

The pulsating x-ray source Cyg X-1 has been reported as having various conflicting or changing periodicities, or as being nonperiodic. The reported data were reanalyzed in an effort to clarify this situation, and were found to be indistinguishable from shot noise due to short overlapping outbursts of x-ray emission, with no true periodicity. Computer-generated shot-noise data had the same appearance and lead to similar power spectra. The observational data were consistent with random pulses which have an effective pulse length of 0.3 ± 0.1 s and occur at varying rates of the order of several hundred per second. The pulse length indicated a maximum source size of ~0.8 light-seconds. It is suggested that some other fluctuating x-ray sources, such as Sco X-1 and Cir X-1, may also have such a shot-noise character. (auth)

34199 NEW TRANSIENT SOURCE OBSERVED BY UHURU. Matilsky, T. A.; Giacconi, R.; Gursky, H.; Kellogg, E. M.; Tananbaum, H. D. (American Science and Engineering, Cambridge, Mass.). Astrophys. J.; 174: No. 1, L53-5(15 May 1972).

A strong x-ray source appeared sometime between March 25, 1971 and August 17, 1971. On August 23, its intensity, as observed by the Uhuru satellite, was about twice that of the Crab Nebula, corresponding to about 3.0×10^{-8} ergs cm^{-2} s^{-1} in the range 2 to 6 keV. On December 20, 1971 its intensity had declined to one-tenth of that value in the same energy range. Its spectrum was quite steep, and fit a power law with an average energy spectral index of 3.0. The variation of x-ray intensity over a 5-month period shows qualitative differences from the previously observed transient x-ray sources, Cen XR-2 and Cen XR-4. (auth)

34200 LOW-FREQUENCY TURNOVER IN THE SPECTRUM OF 3C 391. Goss, W. Miller (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 18: No. 3, 484-6(May 1972).

An investigation of 3C 391 has extended the knowledge of the properties of this supernova remnant to 31.4 GHz. The data lend no support to the hypothesis that a discrete H II region is the cause of the low-frequency absorption in the spectrum of 3C 391. The diffuse recombination lines recently observed are consistent with a free—free optical depth of order unity near 80 MHz needed to explain this low-frequency absorption. (auth)

34201 HIGH INTERFEROMETRIC RESOLUTION OBSERVATIONS OF THE η CARINAE NEBULA. Louise, R. (Observatoire, Marseille). Astron. Astrophys.; 18: No. 3, 475-6(May 1972). (In French).

High-resolution interferometric observations were made on the η Car nebula at the ESO Observatory in the southern hemisphere (La Silla, Chile) during the period of February—March 1970. Line profiles of Hα (λ = 6563 Å) and [N II] (λ = 6584 Å) were derived from these observations at 31 points of the nebula. Generally, the observed line profiles were complex and two or more components were found. So, it was not possible to measure the kinetic temperature following the method used by Courtès et al. (1968) except in 4 points of the nebula where the line profile was gaussian. The temperature and the turbulence were high. (auth)

34202 BASELINE DETERMINATION FOR 21-cm HYDROGEN LINE ASTRONOMY. Wrixon, G. T. (Bell Telephone Labs., Inc., Holmdel, N. J.); Heiles, Carl. Astron. Astrophys.; 18: No. 3, 444-9(May 1972).

A brief review is given of the problems associated with baseline determination in 21-cm line work. The 20-foot horn reflector antenna at Crawford Hill and its associated receiving equipment are described. It is seen that, mainly because of the antenna's unique configuration, this system is free from many of the difficulties normally associated with baseline determination using more conventional equipment. Measurements of 11 regions of very low hydrogen emission made with the Crawford Hill receiving system are presented. These regions, which are distributed in right ascension and declination, include a number of zero-level fields currently being used by Dutch and Australian observers. (auth)

34203 GRAVITY GENERATION OF ELECTROMAGNETIC RADIATION AND THE LUMINOSITY OF QUASARS. Motz, L. (Columbia Univ., New York). Nuovo Cim.; 9B: No. 1, 77-82 (11 May 1972).

A new mechanism is proposed for the emission of radiation by charged particles in a gravitational field whereby the gravitational field is coupled directly to the radiation field of the charge via the principle of equivalence. This leads to a Larmor formula for the electromagnetic power emitted by a charge at rest (on the average) in a gravitational field, which can account for the spectral distribution and the total radiant energy emitted by quasars. This gravitational mechanism for the emission of electromagnetic radiation becomes more important than any other mechanism when the radius of the quasar is near its Schwarzschild radius. (auth)

34204 RADIO EMISSION AT 1400 MHz FROM GALACTIC H II REGIONS. Felli, M. (Arcetri Observatory, Florence); Churchwell, E. Astron. Astrophys., Suppl. Ser.; 5: No. 4, 369-432(Apr 1972).

Observations of 130 areas containing 168 optically identified H II regions with a spatial resolution of 10 arc minutes are reported. Of the 130 regions observed contour maps of 99 regions encompassing 137 Sharpless H II regions are presented. Radio emission was not detected from 31 of the observed regions. In those cases where a radio source could be unambiguously separated from the background emission, the integrated flux density is given in addition to the position, maximum brightness temperature, and radio source size. (auth)

34205 SEARCH FOR INTERSTELLAR FURAN AND IMIDAZOLE. Dezafra, R. L. (Goddard Inst. for Space Studies, New York); Thaddeus, P.; Kutner, M.; (and others). Astrophys. Lett,; 10: No. 1, 1-3(Jan 1972).

Results are reported of an unsuccessful 6-cm search for the hetrocyclic carbon ring molecules furan and imidazole. Upper limits in brightness temperature of 0.25 K or less are found for furan in 11 galactic sources, and of less than 0.1 K for imidazole in Sgr A and Sgr B2. (auth)

34206 NRAO 5-GHz RADIO SOURCE SURVEY. II. THE 140-FT STRONG, INTERMEDIATE, AND DEEP SOURCE SURVEYS. Pauliny-Toth, I. I. K. (Max-Planck Institut fuer Radioastronomie, Bonn); Kellermann, K. I.; Davis, M. M.; Fomalont, E. B.; Shaffer, D. B. Astron. J.; 77: No. 4, 265-84(May 1972).

The 140-ft radio telescope at the National Radio Astronomy Observatory was used at a frequency of 5 GHz to make three separate surveys for discrete sources. The surveys are believed to be essentially complete to 0.6, 0.25, and 0.09 flux unit (f.u.) and cover 0.97, 0.079, and 0.0062 sr, respectively. Positions accurate to a few seconds of arc were determined with the Owens Valley Radio Observatory interferometer for almost all sources above the completeness levels of 0.6 and 0.25 f.u., and the Palomar Sky Survey was searched for identifications. Flux densities were measured at 10.7 GHz and were used, together with the 5-GHz data and previous lower-frequency measurements, to determine the spectra of the sources. The data for the Cambridge 5C1 and 5C2 regions show large differences between the two zones in the spectral-index distribution and number counts. (auth)

34207 SEARCH FOR DISCRETE SOURCES OF COSMIC GAMMA RAYS OF ENERGY 10^{11} TO 10^{12} eV. Weekes, T. C.; Fazio, G. G.; Helmken, H. F.; O'Mongain, E.; Rieke, G. H. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J.; 174: No. 1, 165-79(15 May 1972).

Twenty-seven celestial sources were examined for high-energy γ-ray emission in the previously unexplored region of the electromagnetic spectrum from 10^{11} to 10^{12} eV. An optical reflector of 10-m aperture was used to detect Cherenkov radiation from cosmic-ray air showers; showers induced by γ rays from a discrete source would be apparent as a directional anisotropy. The principal source investigated was the Crab Nebula. Others included supernova remnants, radio galaxies, quasars, magnetic variable stars, pulsars, and x-ray sources, with particular emphasis on M87, M82, 3C 273, and Sgr A. No statistically significant effects were detected, although there was the possibility of a flux associated with the pulsar NP 0532 following the period jump in 1969 September. The observations also suggest a lower limit to the average magnetic field in the Crab Nebula of 6×10^{-4} gauss. (auth)

34208 INTERFEROMETER VISIBILITY SCINTILLATION. Cronyn, Willard M. (National Oceanic and Atmospheric Administration, Boulder, Colo.). Astrophys. J.; 174: No. 1, 181-200 (15 May 1972).

The relationship is developed between the spatial structure of random variations in refractive index, the spatial and temporal structure of the complex visibility function, and the intrinsic angular size of a source. The application is primarily to radio scattering in the interplanetary and interstellar media, where the variations in refractive index are proportional to the irregular structure of electron density. However, the basic theory is relevant to any type of radiation whose coherence properties can be measured with an interferometer. An important conclusion is that analysis of the visibility scintillations of an interferometer whose baseline is σ will yield information about structure as large as $\sim\sigma/1.5$, in contrast to intensity scintillations which only give information about structure smaller than about 0.3 times the Fresnel radius. It is shown that realistic observation times and baselines will conclusively distinguish between power-law and Gaussian spectra for the small-scale structure of the interplanetary electron density. The limitation imposed by the irregularity structure on the coherent integration time for a long-baseline interferometer is discussed. (auth)

34209 REMEASUREMENT OF THE REST FREQUENCY OF THE 36-CENTIMETER RADIO LINE OF METHANOL. Radford,

H. E. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J.; 174: No. 1, 207-8(15 May 1972).

A new laboratory measurement under high-resolution conditions yielded 834.267 ± 0.002 MHz as the rest frequency for the $1_{11}-1_{10}$ methanol emission from the galactic center. Revised Doppler velocities for Sgr A and Sgr B2 are 39 ± 5 and 54 ± 9 km s^{-1}, respectively. (auth)

34210 GYROSYNCHROTRON RADIATION AND ITS TRANSFER IN A MAGNETOACTIVE PLASMA. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 174: No. 1, 135-49(15 May 1972).

Gyrosynchrotron radiation fields from mildly relativistic electrons in a magnetoactive plasma are asymptotically calculated by using the Green tensor and the Fourier transformation. These fields consist of the two components which correspond to the ordinary and extraordinary modes. Taking into account these fields, the emissivities and the absorption coefficients from an arbitrary distribution of electrons are calculated in order to discuss the intensity, spectrum, and polarization of gyrosynchrotron radiation. In general, the transfer of electromagnetic energy takes place along a direction different from that of the wave normal since the radiation fields have a nonvanishing component along the direction of the wave normal. A consideration is given on the problem of radiative transfer in relation to the Stokes parameters. (36 references) (auth)

34211 METER-WAVELENGTH OBSERVATIONS OF GALACTIC RADIO SOURCES AND THE RADIATION FROM THE GALACTIC DISK. Parrish, Alan (Arecibo Observatory, Puerto Rico). Astrophys. J.; 174: No. 1, 33-44(15 May 1972).

The 1000-foot-diameter (305 m) radio telescope at the Arecibo Observatory was used to observe the continuum emission of galactic sources at low radio frequencies. The following sources were observed: W49, W51, W56, NGC 1499, IC 410, NGC 2175, and NGC 2244. Observations were made at seven frequencies: 53, 65, 74, 89, 111, 196, and 318 MHz. Arrangements were made to obtain data on several of these frequencies simultaneously. Flux densities of the observed sources are presented at the low frequencies. The data were also analyzed to obtain an estimate of the electron temperature of each thermal source, as well as the brightness temperature level of the nonthermal radiation in the line of sight to and beyond each source. The derived electron-temperature results were sufficiently accurate to be compared with the results of recombination-line observations of NGC 2244. A range of pairs of permissible electron temperatures and background brightness—temperature levels was obtained for each of the other sources. Given this data, independent knowledge of the electron temperature of a source determines its associated background brightness—temperature level, and the latter result may be used in estimating the spatial distribution of the galactic nonthermal radiation. (auth)

34212 RADIATION-PRESSURE-DRIVEN MASS LOSS FROM QUASI-STELLAR OBJECTS. Mushotzky, R. F.; Solomon, P. M.; Strittmatter, P. A. (Univ. of California, San Diego). Astrophys. J.; 174: No. 1, 7-15(15 May 1972).

It is shown that radiation pressure acting on the material in the outer envelopes of QSOs will cause mass outflow unless the mass M of the QSO exceeds a critical value M_S. If the QSOs are at cosmological distances, M_S is of order 10^{10} to 10^{11} $M_\odot$, and otherwise scales according to intrinsic luminosity. Radiation-pressure—driven mass loss could be responsible for the absorption-line spectra observed in many QSOs. If so, the presence of blueshifted absorption lines in some but not all QSOs indicates that typically M is of the same order as M_S. It is also suggested that under radiative acceleration certain ratios of emission-line absorption-line redshifts may be preferred as a result of a "line-locking" mechanism. Inferences are made concerning the magnitude of the gravitational component of the redshift. Possible tests of various aspects of the model are discussed. (auth)

34213 INDUCED LIGHT PRESSURE UNDER ASTROPHYSICAL CONDITIONS. Levich, E. V. (Inst. of Chemical Physics, Moscow); Sunyaev, R. A.; Zeldovich, Ya. B. Astron. Astrophys.; 19: No. 1, 135-9(Jun 1972).

The radiation of compact sources with high brightness temperature $kT_b > m_e c^2$ in the low-frequency region creates great force acting on free electrons due to induced Thomson scattering. This induced radiation pressure exceeds the well-known pressure due to spontaneous scattering by the coefficient α^4 (kT_b/m_ec^2), where α is the mean angle between light rays. The effect is of importance for plasma dynamics in the vicinity of pulsars, quasars, galactic nuclei, and maser-type sources. (auth)

34214 ENERGY BALANCE OF THE CRAB NEBULA AND THE VELA X REMNANT. Boerner, Gerhard (Max-Planck-Institut fuer Physik und Astrophysik. City Coll., New York); Cohen, Jeffrey M. Astron. Astrophys.; 19: No. 1, 109-12(Jun 1972).

To balance the energy losses from the Crab Nebula, energy must be supplied continuously. The short lifetime of the electrons producing the optical and d-ray synchrotron radiation puts a lower limit on the energy output from the Crab. This can be supplied by a rotating neutron star with the period and rate of change of the period of the Crab pulsar if its moment of inertia is at least 1.8 × 10^{44} g cm^2. Conclusions based on the expanding supernova shell are not as definite. If the currently accepted values for acceleration and snow-plow are used, additional energy must be supplied. This energy can be obtained from a neutron star with a moment of inertia of 10^{45} g cm^2. For the equation of state used these moments of inertia imply that the mass of the star is greater than 0.34 and 1.2 $M_\odot$, respectively. If little material was lost during the collapse, the star would have had a mass of 1.35 $M_\odot$ prior to the collapse above the Chandrasekhar limit for typical white dwarfs. It is suggested that the Vela pulsar's "glitch" energy is sufficient to maintain the ionization of the Gum Nebula. (auth)

34215 INTERPRETATION OF ROTATION MEASURES OF RADIO SOURCES. Reinhardt, Michael (Inst. of Theoretical Astronomy, Cambridge, Eng.). Astron. Astrophys.; 19: No. 1, 104-8(Jun 1972).

The rotation measures of 98 extragalactic radio sources with known redshifts are statistically investigated. A significant contribution to the rotation measures by a uniform field was found for quasars, but not for radio galaxies which is probably due to larger intrinsic rotation measures for this class of objects. The additional evidence provided by the rotation and dispersion measures of 19 pulsars suggests that the systematic behavior of the rotation measures of quasars is to a large extent due to the galactic magnetic field, although an intergalactic contribution cannot be excluded. Estimates of the direction and strength of the uniform component of the galactic magnetic field are given. Upper limits are set to the field strength of a homogeneous intergalactic magnetic field. (auth)

34216 H II REGIONS IN THE SCO OB 1 ASSOCIATION. Laval, A. (Observatoire, Marseille). Astron. Astrophys.; 19: No. 1, 82-91(Jun 1972).

Two bright nebulae are related to the Sco OB 1 association. RCW 113 is situated in the southern part, IC 4628 in the northern part. The purpose of this study is to show whether the two observed H II regions originated at the same time from the same initial gas cloud. Optical and radio-astronomical data were used. (W.D.M.)

34217 CIRCULARLY POLARIZED RADIATION FROM EXTRAGALACTIC RADIOSOURCES. Rosenberg, Hans (Univ., Utrecht). Astron. Astrophys.; 19: No. 1, 66-70(Jun 1972).

Two mechanisms that might explain the recently observed circular polarization in quasistellar objects are investigated. A second-order effect in synchrotron radiation from an isotropic velocity distribution can explain the observed degree of circular polarization, but requires in a realistic case of inhomogeneous magnetic field distribution a magnetic field strength of ~1 G. Transformation of linear polarization into circular polarization due to the Faraday pulsation in a layer where the quasi-transverse propagation condition holds can also explain the observed circular polarization, but requires magnetic field strengths of ~5 G. This effect will predominantly take place in compact sources with flat electron energy spectra, and does explain the observed unrelatedness of the circular polarization at different frequencies. (auth)

34218 CONFUSION ERROR ON THE FLUX ESTIMATE OF A POINT SOURCE. Burns, W. R. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 19: No. 1, 41-4(Jun 1972).

The estimation of the flux of a point source is considered. The error, due to confusion, on the estimate is given and the relation of this error to the shape of the antenna power pattern. The effect of this shape on the confusion level was the primary question of interest. With radio-interferometric synthesis becoming more common, one is frequently left with a complex shaped power pattern. In such a case the classical results in terms of number of beam widths per source simply no longer apply. In partial synthesis work, due to the complex shape of the power pattern the term beamwidth is in fact not always defined. Expressions are given for the variance on three quantities, the confusion noise on the record, the flux estimate assuming a known baseline, and the baseline estimate. Some examples are given and their implications discussed. (auth)

34219 ABSOLUTE TIMING OF THE CRAB NEBULA PULSAR, NP 0532. Groth III, Edward John. Princeton, N. J.; Princeton

Univ. (1971). 194p. University Microfilms Order No. 72-14,148. Thesis.

Absolute times of arrival of NP 0532 pulses were measured over a two-year period. The data are shown to be consistent with a cubic braking function, a glitch function derived from a two component model of neutron-star structure, and an intrinsic shot noise component in the pulse frequency. (Diss. Abstr. Int., B)

34220 PHYSICAL CONDITIONS IN INTERSTELLAR HYDROXYL AND FORMALDEHYDE CLOUDS. Davies, R. D.; Matthews, H E. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 253-62(1972).

The physical conditions in interstellar clouds which contain the molecules OH and H_2CO were derived from an investigation of the H, OH, and H_2CO absorption spectra of Cas A, Cyg A, and Tau A. The derived parameters of the typical molecule-bearing cloud are listed along with the estimates of the visual obscuration and ultraviolet-radiation field. These clouds with neutral-hydrogen densities in the range 2 to 70 cm^{-3} are evidently the higher density part of the distribution of interstellar clouds found in other neutral hydrogen investigations. It is shown that the lifetime of a molecule in the clouds is 10^{-5} to 10^{-4} of the lifetime of a typical cloud; this requires that the molecules should be continually formed. Most theories of OH molecule formation are inapplicable in the conditions found in these clouds. The physical parameters presented here should provide the basis for realistic theories of the formation of interstellar molecules. (auth)

34221 NUMERICAL STUDY OF THE DYNAMICS OF H II REGIONS. Hill, J. G.; Marsh, M. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 189-206(1972).

A numerical study was made of the dynamics of H II regions governed by the radiation—hydrodynamic equations of Goldsworthy (1961). The difference equations are explained and applied to plane similarity problems with constant ambient density. It is seen that several meshes per recombination length are necessary to ensure the correct solution for flows in which the ionization front is strong D-type. The existence of isothermal shocks in the H II region is demonstrated for some of these constant density situations. (auth)

34222 GALACTIC STRUCTURE AND THE APPARENT SIZE OF RADIO SOURCES. Readhead, A. C. S.; Hewish, A. (Cavendish Lab., Cambridge, Eng.). Nature (London); 236: No. 5348, 440-3(28 Apr 1972).

Observations of radio sources at 81.5 MHz show that interstellar scattering is more important than some pulsar data suggest. Low-frequency measurements also provide a new means for studying the distribution of ionized gas in the Galaxy. (auth)

34223 VARIABLE OF RADIO SOURCES AND SPECTRAL TYPE. Andrew, B. H.; Medd, W. J.; Harvey, G. A.; Locke, J. L. (National Research Council of Canada, Ottawa). Nature (London); 236: No. 5348, 445-7(28 Apr 1972).

It has been assumed that variability is likely to occur in sources with centimeter-excess spectra, and this relationship is here established without doubt and in a quantitative form. It is estimated that 90 to 100% of sources with cm-excess spectra are variable, and it is also established that no source with a normal spectrum shows any evidence of variations. These conclusions are based on observations, made over several years at the Algonquin Radio Observatory, of 84 suspected variable sources, at 6.7 and 10.6 GHz. Only the association with spectral type was found to be a dependable indicator of variability. By a cm-excess spectrum is meant a spectrum having a maximum at cm wavelengths or that is typified in the cm region by a spectral index $\alpha \lesssim 0.3$. (UK)

34224 SEARCH FOR X-RAYS ABOVE 100 keV FROM THE VICINITY OF NP 0527. Kurfess, J. D. (Naval Research Lab., Washington, D. C.); Meidav, M.; Sadeh, D. S. Nature (London); 236: No. 5348, 447-8(28 Apr 1972).

A pulsating x-ray source near the Crab Nebula and NP 0527 has been reported, with a period of 3.8266 sec, using balloon-borne proportional counters in the 30- to 100-keV region. This period is ~2% greater than the period of NP 0527, the radio pulsar which is ~1° from the Crab. A search is described for evidence of pulsed emission in 100- to 400-keV data obtained on balloon flights, using a large NaI(Tl) detector, in Oct. 1970. No evidence of pulsation at periods near 3.8266 sec was found. Interpretations are offered for the discordant data at 30 to 100 keV. (UK)

34225 OPTICAL COUNTERPART OF CEN X-3. Shklovskii, J. S.; Cherepashchuk, A. M.; Efremov, Yu. N. (Sternberg Astronomical Inst., Moscow). Nature (London); 236: No. 5348, 448 (28 Apr 1972).

It is suggested that the x-ray source Cen X-3 may be identified with the Algol-type variable LR Cen, based on the proximity of their coordinates and on the close values of their orbital periods. Some of the optical characteristics of the system are discussed. (UK)

34226 IDENTIFICATION OF CEN X-3. Peterson, B. A. (Australian National Univ., Canberra). Nature (London); 236: No. 5348, 449(28 Apr 1972).

X-ray observations of the pulsating x-ray source Cen X-3 indicate that it is a component of an eclipsing binary with a circular orbit of radius 0.08 AU, the optical counterpart possibly being LR Cen. Data for the position and period of Cen X-3 and its suggested optical counterpart, and for the photometry of the variable star LR Cen, are given; the photometric data were obtained with the 40-inch reflector at the Siding Spring Observatory. (UK)

Solar Phenomena

Refer also to abstracts 34039, 34045—34047, 34060, 34072, 34076, 34092, 34093, 34102, 34104—34106, and 34374.

34227 SPECTROPHOTOMETRIC STUDY OF A CHROMOSPHERIC FLARE JULY 8, 1966. Musaev, M. M. (Shemakhin Astrophysical Observatory, USSR). Izv. Akad. Nauk Azerb. SSR, Ser. Fiz.-Tekh. Mat. Nauk; No. 1, 73-8(1971). (In Russian).

A flare located on the northwest edge of the solar disc ($\sin \theta = 0.93$) in a developing sunspot group was examined with a diffraction spectrograph at 16 hours Moscow time on July 8, 1966. The spectrum of the flare is discussed within the framework of the H and K, Ca II, H_δ, H_ϵ, and H_8 lines of hydrogen, and also the lines λ4077 and 724 Å of Sr II. (K.S.W.)

34228 α-EFFECT DYNAMOS, BY THE BULLARD—GELLMAN FORMALISM. Roberts, P. H.; Stix, M. (National Center for Atmospheric Research, Boulder, Colo.). Astron. Astrophys.; 18: No. 3, 453-66(May 1972).

The Bullard—Gellman method of obtaining homogeneous dynamos of spherical form is generalized to solve the mean field induction equation. In the same way in which Bullard and Gellman expanded velocity and magnetic field in spherical harmonics, the α-effect scalar field is expanded and the corresponding interactions are computed. (W.D.M.)

34229 CORONAL SCATTERING OF RADIOBURSTS AT HECTOMETER AND KILOMETER WAVELENGTHS. Steinberg, J.-L. (Observatoire, Meudon, France). Astron. Astrophys.; 18: No. 3, 382-9(May 1972).

Using a Monte-Carlo ray-tracing technique, the effects of coronal scattering on hectometer and kilometer wavelength solar bursts were computed. Between 0.2 and 3 MHz, Type-III space observations are available and propagation takes place between 6- and 200-solar-radii altitudes. In this range of altitudes, the size l and rms electron density deviation of the coronal inhomogeneities can be deduced from the observations of radio-source scintillation and angular broadening. (W.D.M.)

34230 EMISSION AT FREQUENCIES MUCH HIGHER THAN THE PLASMA FREQUENCY AND TYPE III SOLAR RADIO BURSTS. Smith, Dean F. (National Center for Atmospheric Research, Boulder, Colo.). Astron. Astrophys.; 18: No. 3, 403-7(May 1972).

The possibility that radiation at frequencies much higher than the plasma frequency plays a role in Type III burst sources at low frequencies is examined. It is shown that in order for such radiation to be important, it must be amplified. If the source is an electron stream, the most important process for such radiation is inverse Compton scattering of thermal plasma waves on the electrons of the stream. However, amplification of this radiation by the same stream is negligibly small and hence this mechanism is of no importance. If the source is a proton stream, the most important process for radiation well above the plasma frequency is nonlinear scattering of thermal plasma waves on the protons of the stream. Again, amplification of this radiation by the same stream is negligibly small and hence this mechanism is not important. It is concluded that most of the radiation of Type III bursts at low frequencies is near the fundamental of the plasma frequency by considering the observed or apparent directivity of the radiation. Hence the plasma hypothesis is valid all the way to the orbit of the Earth. (auth)

34231 DECAY OF THE MAGNETIC FIELD IN A REGION GENERATING A SOLAR MICROWAVE BURST. Basu, D.; Scalise, E. Jr. (Univ. Mackenzie, Sao Paulo, Brazil). Astrophys. Lett.; 10: No. 1, 13-15(Jan 1972).

The decay of the magnetic field in the region of a solar radio burst was evaluated from the time profile of the degree of circular polarization of a burst at 7 GHz. (auth)

34232 SUPERGRANULATION-DRIVEN ALFVEN WAVES IN THE SOLAR CHROMOSPHERE AND RELATED PHENOMENA. Hollweg, Joseph V. (California Inst. of Tech., Pasadena). Cosmic Electrodyn.; 2: No. 4, 423-44(Jan 1972).

It has recently been recognized that Alfvén waves frequently dominate the microstructure of the solar wind at the orbit of Earth. A solar source for these waves and their excitation by the supergranular motions are studied. The wave equation is solved in a horizontally stratified, bi-exponential solar atmosphere. If the rms supergranular velocity is 0.4 km/s and B_0 = 2 G, an energy flux of 4×10^3 ergs cm^{-2} s^{-1} is obtained; this flux is envisioned as dissipating in the solar wind, and is of sufficient magnitude to account for the difference between the two-fluid solar-wind model and observation, as discussed by Hartle and Barnes (1970). Modest increases in B_0 or the rms supergranular velocity lead to substantially higher energy fluxes, and could account for high-velocity solar wind streams. The interaction of Alfvén-wave motions associated with adjacent supergranules is discussed qualitatively. The Alfvén wave effectively conveys the supergranular motions to great heights in the chromosphere. These motions are oppositely directed above intersupergranule boundaries, and compress the magnetic field there. A naive calculation of the compression, based on balancing dynamic and magnetic pressures, leads to adequate agreement with observations of the chromospheric network. It is found that the magnetic field is appreciably compressed only below about 1500 km, and on this basis, theories of spicule formation that require large vertical magnetic fields at the heights reached by spicules are rejected. The compressed magnetic-field configuration is such as to lead to downward deflection of the Alfvén-wave motion, and it is suggested that this may at least partially explain the net downward motion of the Hα, Hβ chromospheric network. A theory is advanced for spicule formation, in which spicules form as a result of matter being squeezed upward, but of the compression region between adjacent supergranules. All salient features of spicules are accounted for in a natural way. (auth)

34233 MAGNETIC ENERGY FLOW IN THE SOLAR WIND. Modisette, Jerry L. (Houston Baptist Coll., Tex.). Astrophys. J.; 174: No. 1, 151-2(15 May 1972).

The effect on magnetic energy flow of rotation of the Sun is shown to result in most of the magnetic energy being transported by magnetic shear stress near the Sun. (auth)

34234 PLASMA RADIATION FROM COLLISIONLESS MHD SHOCK WAVES. II. PLASMA-WAVE GENERATION AND TRANSFORMATION PROCESSES. Smith, D. F. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 174: No. 1, 121-34(15 May 1972).

The distribution of plasma waves that results when beams of electrons produced in a collisionless magnetohydrodynamic shock wave enter into the upstream plasma is examined. The upstream region is divided into two parts, a relaxation region in which the beams lose their directed energy and a forward region to which plasma waves with sufficiently high group velocity escape. Losses of plasma waves in the relaxation region due to escape to the forward region and into the shock are taken into account to establish a minimum beam density for self-consistency. Nonlinear processes are analyzed to determine the angular distribution of plasma waves. Processes for the transformation of plasma waves into radiation are considered. It is shown that interaction of plasma waves with the density inhomogeneity of the shock front will lead to negligible radiation. The process $p + s \rightarrow t$, where p is a plasma wave, s is an ion-acoustic wave, and t is a transverse wave, will not be important in the shock front due to the difficulty in satisfying the momentum conservation condition. The only significant transformation process for emission near the fundamental of the plasma frequency in the shock front and the upstream region is scattering on the polarization clouds of ions, $p + i \rightarrow t(\omega_p) + i'$ is an ion. The absorption coefficient for this process can be negative, and hence a transfer problem must be solved to determine the total radiation. The only important transformation process for emission near the second harmonic of the plasma frequency is combination of two excited plasma waves, $p + p \rightarrow t(2\omega_p)$. Since the cone of plasma waves is an anisotropic and the two excited plasma waves must meet almost "head-on," spontaneous scattering of plasma waves must be taken into account in computing this combination process. Because the shock front is much narrower than the relaxation or forward regions, only the latter need to be considered in computing the radiation. (auth)

34235 ANISOTROPIC COSMIC-RAY PROPAGATION IN AN INHOMOGENEOUS MEDIUM. I. THE SOLAR ENVELOPE. Burlaga, L. F. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 9-16(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A phenomenological, 1-dimensional model of solar cosmic-ray propagation is presented which allows one to compute both the anisotropy and the intensity as a function of time during the early phases of certain events. It applies for arbitrarily large anisotropies, ranging from 0 to 1, and is valid for even the earliest times. Thus, it is not subject to the restrictions of earlier models based on the diffusion equation or telegraph equation. The model assumes that cosmic rays are released instantaneously and effectively interact with isolated scattering centers which are distributed uniformly throughout the solar wind. Each scattering center is assigned a probability $P(x_i)$ that a cosmic ray will be reflected by it; this function ranges from 0 to 1 and can be any function of position. The mathematical formulation of the model consists of a set of difference equations involving $P(x_i)$ and the probabilities f^+ and f^- of finding a particle moving away from or toward the source, respectively, at a given time and position. The model is used to examine the general effects of a diffusing region close to the Sun (the solar envelope) on solar cosmic-ray propagation. The model, applied to the >1.1 GV protons of the May 4, 1960, event, gives a good fit to the intensity-time curve for the "sunward" flux and correctly gives a negligible "anti-Sun" flux throughout the event. The characteristic dimension and diffusion coefficient of the diffusing region are found to be 27 $R_\odot$ and $D_{max} = 10^{21}$ cm^2/sec, respectively. It is suggested that the solar envelope may be identified with an extended solar-wind heating region and that the cosmic-ray scattering may be due to the hydromagnetic waves which Barnes has postulated as the energy source. (auth)

34236 INFORMATION ON SOLAR WIND PROPERTIES ACCORDING TO THE DATA ON COSMIC-RAY ANISOTROPY. Dorman, L. I.; Inozemtseva, O. I. (IZMIRAN, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 27-30(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Experimental data are presented on diurnal variations of the cosmic neutron component for the periods after proton flares in July, August, and September of 1966 and in January 1967. The properties of cosmic-ray anisotropy in these periods are discussed on the basis of experimental data. It is shown that at a sufficiently stable phase the variation amplitude is increased on some days by almost an order of magnitude as compared with quiet days. The anisotropic diffusion model as applied to the observed values of the amplitude and diurnal variation phase is examined. The gradient of cosmic-ray density is compared on the basis of specific data on diurnal anisotropy for various values of parameters forming parts of the diffusion equation, i.e. particle rigidity, scattering path, solar-wind velocity, and magnetic-field strength. The calculated values of the radial and azimuthal gradients are compared with experimental data. The applicability of the diffusion model to diurnal anisotropy after proton flares is demonstrated. (auth)

34237 COMPARISON OF PARTICLE–FIELD INTERACTION THEORY WITH SOLAR-PROTON DIFFUSION COEFFICIENTS. Wibberenz, G. (Univ., Kiel); Hasselmann, K.; Hasselmann, D. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 37-46(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The mean free path $\lambda_{||}$ of cosmic rays in interplanetary space is derived from particle–field interaction theory. For power law magnetic field spectra, $f(k) \sim k^q$, $\lambda_{||}$ is finite only for $q > -2$. A bounding factor at small wavenumbers yields finite $\lambda_{||}$ for all q. The asymptotic behavior of $\lambda_{||}$ for small rigidities is logarithmic for $q = -2$ and constant for $q < -2$. The importance of the detailed structure of the magnetic field spectral tensor is stressed, particularly for steep spectra and at small wavenumbers. The agreement with the numerical values derived from solar proton propagation is good close to solar minimum. For higher solar activity the experimental diffusion coefficients are systematically larger than the theoretical values based on magnetic field power spectra. (auth)

34238 POWER SPECTRAL STUDIES OF THE INTERPLANETARY MAGNETIC FIELD. Sari, J. W. (Univ. of Maryland, College Park); Ness, N. F. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 373-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Power spectra of fluctuations in the interplanetary magnetic field covering the range of 2.0×10^{-6} to 1.6×10^{-2} Hz have been obtained for the period of December 1965 to June 1966 utilizing data from the Pioneer 6 satellite. For frequencies greater than 10^{-4} Hz spectra computed during quiet field conditions vary in frequency dependence as f^{-2} and are found to be related to directional discontinuities in the interplanetary magnetic field. During disturbed field conditions, the spectra are dominated by fluctuations between the discontinuities and vary in frequency between $f^{-5/3}$ to $f^{-4/3}$. Spectra taken over 10 day intervals exhibit an $f^{-5/3}$ dependence typical of the disturbed periods. (auth)

34239 GRADIENT AND CURVATURE DRIFTS OF ENERGETIC SOLAR PARTICLES IN THE SOLAR WIND. Jokipii, J. R. (Univ. of Chicago). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 379-85(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The curvature and gradient of the average interplanetary magnetic field are combined with the usual diffusion, or Fokker—Planck equation for particle motion. These drifts are not negligible and provide a natural interpretation of recent observations of >500 keV solar protons and >45 keV solar electrons, in which it is found that the electrons lead the protons by up to several hours. The combination of both the curvature drift and gradient drift in the solar wind is such that protons should lag behind electrons as a quasi-steady beam rotates with the Sun. The magnitude of the separation is found to be in agreement with observation, if the effective diffusion mean-free-path for ≈1 MeV protons is of the order of 3×10^{11} cm, which is reasonable. (auth)

34240 GROUND-BASED AND SATELLITE OBSERVATIONS OF THE JANUARY 28, 1967 SOLAR FLARE EVENT. Bukata, R. P. (Southwest Center for Advanced Studies, Dallas, Tex.); Gronstal, P. T.; Palmeira, R. A. R.; McCracken, K. G.; Rao, U. R. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 387-91(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Pioneer 6 and 7 and ground-based neutron monitor observations of the January 28, 1967 solar flare event have shown that a) the most probable location for the parent flare was ~60° beyond the western solar limb; b) both the ≥7.5 MeV and the ≥0.5 GeV particle fluxes recorded at the observation stations were essentially isotropic, indicative of particle diffusion across the interplanetary magnetic field lines; c) the spectral exponent of the differential rigidity spectrum at high energies was -4.8 ± 0.2; and d) a conservative estimate of the nondiffusive particle flux is 2×10^3 particles cm^{-2} sec^{-1} sr^{-1} above 7.5 MeV. (auth)

34241 ENERGY SPECTRA OF PROTONS AND ALPHA PARTICLES DURING THE FEBRUARY 25, 1969 SOLAR EVENT. Green, G.; Krieger, R.; Wibberenz, G.; Witte, M. (Univ., Kiel). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 393-9(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1069).

During the ESRO PCA-campaign two centaur rockets were launched from Andenes, Norway ($\lambda_{inv} = 66.3°$), 7.3 and 14.6 hours after the February 25, 1969 solar proton flare. Proton spectra for the two flights between 30 and 100 MeV/N, if represented as exponentials in rigidity, have e-folding rigidities of $P_0 = 90 \pm 10$ MV and $P_0 = 76 \pm 10$ MV, respectively. The ratio between the intensities indicates rather fast interplanetary propagation for this event. Proton-to-alpha ratios on an energy/nucleon basis between 24 and 75 MeV/N are 88 ± 15 and 190 ± 50 for the two flights. The geomagnetic cutoff at Andenes is lower than 240 MV both at 1733 and 0050 LT. (auth)

34242 SOLAR-FLARE INCREASES IN COSMIC-RAY INTENSITY ON NOVEMBER 18, 1968, FEBRUARY 25, 1969, AND MARCH 30, 1969. Venkatarangan, P. (Univ. of Calgary, Alberta); Venkatesan, D.; Van Allen, J. A. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 409-20(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Flare-type increases in cosmic-ray intensity were registered by high-latitude neutron monitors on November 18, 1968; February 25, 1969; and March 30, 1969. Data were also available for these events from various detectors of the University of Iowa, on board the satellite Explorer 35. Analyses of intensity time profiles for the events are presented pertaining to protons, alpha particles, and heavy ions ($Z > 2$). The results exhibit considerable differences from event to event. The implications of the observations are discussed. (auth)

34243 CHARACTER OF COSMIC-RAY FLARES. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 427-32(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

On the flare with the ejection of cosmic rays of November 11, 1968 one shows some typical features of the flare with the ascent of the magnetic tube in the system of the opposite magnetic field of the spot group. By means of the application of known mechanisms one can explain the origin and space development of these flares with the characteristic emissions. The energy of ejected particles and photons draws from the energy of the magnetic fields in the process of their annihilation. (auth)

34244 SOLAR PROTON EVENTS OF FEB. 25 AND 27, 1969. 1. PARTICLE FLUXES IN INTERPLANETARY SPACE. Engel, A. R.; Balogh, A.; Elliot, H.; Hynds, R. J.; Quenby, J. J. (Imperial Coll. of Science and Tech., London). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 439-44(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Measurements are reported from the HEOS A-1 satellite of the solar proton flux from the flares of February 25 and February 27, 1969. Directional observations were made at >1 MeV and >360 MeV and the total flux at intermediate energies was also monitored. The results were consistent with velocity dependent diffusion. A strong backscattering of 360 MeV, but not 1 MeV particles was observed. (auth)

34245 SOLAR PROTON EVENTS OF FEB. 25 AND 27, 1969. 2. INTERPRETATION OF CORRELATED INTERPLANETARY MAGNETIC FIELD AND PARTICLE MEASUREMENTS. Quenby, J. J.; Balogh, A.; Engel, A. R.; (and others) (Imperial Coll. of Science and Tech., London). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 445-51(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Particle and field measurements on the February 25, 1969 solar proton event are consistent with an anisotropic, velocity dependent diffusion model at low energies with a mean free path $\approx 10^{12}$ cm. The local interplanetary field strongly influences the measured particle anisotropy. (auth)

34246 SOLAR PROTON EVENTS OF FEB. 25 AND 27, 1969. 3. COMPARISON OF PARTICLE MEASUREMENTS CLOSE TO THE EARTH AND IN INTERPLANETARY SPACE. Balogh, A.; Durney, A. C.; Elliot, H.; (and others) (Imperial Coll. of Science and Tech., London). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 453-7(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Some simultaneous measurements over the polar caps and in interplanetary space are presented for the Feb. 25 flare event. These confirm the idea that the polar cap flux shows more structure than in interplanetary space, both at 1 to 2 MeV and at 350 MeV. It is suggested that the cause of the additional structure lies in a modulation introduced by the outer magnetosphere rather than anisotropies or flux gradients in interplanetary space. (auth)

34247 DIFFUSION MODEL AND INJECTION SPECTRA OF SOLAR-FLARE PROTONS. Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 471-3(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The diffusion model of the propagation of solar cosmic rays in interplanetary space was studied under the assumption that the coefficient of diffusion depends on the rigidity of the particles and the distance from the Sun. Using this model the injection spectra were obtained for a number of flares from 1956—1967. A tendency was found towards the bend of the spectrum on transition to a region of small rigidities. The qualitative agreement between the spectra of nonrelativistic protons and electrons, causing x-ray and radiowave radiation of the flares, is pointed out. (auth)

34248 ENTRY OF SOLAR PROTONS INTO THE GEOMAGNETIC FIELD DURING THE EVENT OF JUNE 9, 1968. Quenby, J. J. (Imperial Coll. of Science and Tech., London). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 475-80(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The minimum latitudes of arrival for solar protons in the energy range 2 to 90 MeV are found. The particles arrive at latitudes lower than would be expected on a field model determined by the internal field, the magnetospheric boundary currents, the magnetotail, and the ring current. At quiet times, scattering by waves in the magnetosphere may explain the anomalous entry but during the main phase of a magnetic storm drift motion caused by electric fields associated with the build-up of the main phase ring current seems to be important. (auth)

34249 SOLAR PROTON EVENT OF JUNE 9, 1968 OBSERVED FROM THE ESRO II SATELLITE. Haskell, G. P.; Hynds, R. J. (Imperial Coll. of Science and Tech., London). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 481-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Protons in the energy range 2 to 17 MeV were observed over the polar caps. The structure in the flux profiles across the caps was studied. Changes in this structure were examined as functions of universal time, magnetic local time, and magnetic activity at the Earth. (auth)

34250 SOLAR COSMIC RAYS ON MAY 25 AND 28, 1967 ACCORDING TO STRATOSPHERIC MEASUREMENT DATA. Bazilevskaya, G. A.; Golenkov, A. E.; Kvashnin, A. N.; (and others) (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 501-3(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Cosmic-ray intensity increases in the stratosphere caused by chromospheric flares at the end of May 1967 are discussed. Stratospheric data are compared with the results of measurements of solar proton intensity from Explorer-34 and with riometer data at Apatity. In the event of May 28 and 29 the exponent of differential spectrum of solar protons was 1.4 in the energy range E_p = 10 to 60 MeV according to Explorer-34 data and ≈3.5 in the energy range E_p = 100 to 300 MeV according to stratospheric data. (auth)

34251 ANOMALOUS FLUXES OF SOFT PHOTONS IN THE STRATOSPHERE DURING COSMIC-RAY BURSTS IN MAY 1967. Bazilevskaya, G. A.; Kvashnin, A. N.; Charakhchyan, A. N.; Charakhchyan, T. N. (Lebedev Inst. of Physics, Moscow. Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 505-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Anomalous photon fluxes with energies >20 keV were detected in the stratosphere on May 25 and 28 1967 in association with solar protons. It is likely that on May 25 the excess photon flux was produced in nuclear reactions of solar low-energy photons with air nuclei in the upper stratosphere. The photon flux on May 25 was produced by bremsstrahlung of electrons precipitating from the outer radiation belt. (auth)

34252 GENERATION OF PROTONS AND X-RAY SPLASHES ON THE SUN. Gainova, L. E.; Ivanov, V. I.; Kolomeets, E. V.; Kobzev, V. A. (Kazakh State Univ., Alma-Ata, USSR). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 509-11(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The total number of protons and electrons in solar flares together with the energy spectrum of electrons was calculated on the basis of observations of x-ray splashes and the acceleration mechanism suggested by Syrovatsky. (auth)

34253 DISCUSSION OF SOLAR COSMIC-RAY ACTIVITY NEAR SUNSPOT MAXIMUM. Masley, A. J.; Satterblom, P. R. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 513-19(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Sixteen solar cosmic-ray events were observed during 1968 and 12 during the first seven months of 1969. This represents an increase in activity as the peak in the solar cosmic-ray cycle is approached. The events under discussion range in maximum intensity from 0.5 dB to 12.5 dB absorption at 30 MHz or $2/\text{cm}^{-2}$ sec^{-1} sr^{-1} to $3 \times 10^3/\text{cm}^{-2}$ sec^{-1} sr^{-1} for protons with energy greater than 10 MeV. An increased number of events due to southern hemisphere solar flares was observed during 1968, continuing a pattern which began in late 1967. Six of the 16 events observed during 1968 were due to southern flares. Possibly two of the late 1967 events were also due to southern hemisphere flares. This can be compared to one or two such cases for the 15 events observed from 1962 to 1967. Activity during the first six months of 1969, however, shows no evidence for continuation of enhanced southern hemisphere activity, based on preliminary solar information. The two largest events observed during the period under discussion were the November 18, 1968 event with 12.5 dB and the April 11, 1969 event with 12 dB. The November 18 event had a significant relativistic component as measured by neutron monitors. The April 11, 1969 event was the only event larger than 2 dB during 1969 and is particularly interesting because it was apparently due to solar activity behind the east limb. The June 7, 1969 event was observed simultaneously by McDonnell Douglas experiments at the polar ground-based observatories and on the polar orbiting OGO-VI satellite. (auth)

34254 INTERACTION OF ENERGETIC PARTICLES WITH THE NEUTRAL SHEET OF THE GEOMAGNETIC TAIL. Alekseev, I. I.; Kropotkin, A. P. (Moscow State Univ.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 521-4(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The motion of energetic particles in the neutral sheet of the magnetospheric tail, though nonadiabatic, is shown to conserve the first adiabatic invariant. The corresponding current of energetic particles is evaluated. The steady state pitch-angle distribution of particles in the geomagnetic tail, $f(\theta) \sim |\sin 2\theta|$ is found, which is the limiting form of transient distributions on some assumptions. (auth)

34255 EFFECT OF ASYMMETRIC MAGNETOSPHERE ON RESPONSE OF HIGH-LATITUDE NEUTRON MONITORS TO SOLAR-PARTICLE EVENTS. Shea, M. A.; Smart, D. F. (Air Force Cambridge Research Labs., Bedford, Mass.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 539-43(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The response of very high-latitude neutron monitors is often inconsistent in both onset time and percentage increase from the expected behavior using classical cosmic-ray theories. The best illustration of these inconsistencies is contained during the anisotropic portion of the November 15, 1960 solar cosmic-ray event. In this analysis a model of the magnetosphere was used to calculate the asymptotic directions for cosmic-ray protons detected by high latitude neutron monitors. It is shown that with these improved calculations only very simple assumptions regarding solar particle propagation are required in order to satisfactorily explain some of the apparent inconsistencies observed by neutron monitors during solar particle events. Specifically, the onset times and increases observed at various stations can be explained by the effect of the asymmetric magnetosphere on the asymptotic directions, and the direction of viewing for each station as a function of rigidity at the time of the event. It is concluded that the asymptotic directions for each high-latitude neutron monitor must be calculated for the onset time of the event since the shape and direction of viewing of the asymptotic cones of these stations for solar cosmic-ray rigidities is a function of local time. (auth)

34256 MULTIPLE NEUTRON STUDIES OF UNUSUAL COSMIC-RAY INCREASES DURING 1967–1969. Kodama, M. (Inst. of Physical and Chemical Research, Tokyo); Suda, T.; Ogura, K. Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 571-6(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Analytical investigations are given of three solar proton events occurring in 1967–1969, on the basis of multiplicity measurements in the NM-64 neutron monitor at Syowa, Antarctica. The rigidity spectrum of the solar protons is deduced from the neutron intensity increases detected for six different multiplicities. It is shown that the results obtained are consistent with those deduced using neutron data collected from a number of cosmic-ray stations. However, multiplicity measurements seem to be effective for solar proton events connected with increases which are at least ten times greater than statistical fluctuations at higher multiplicities. (auth)

34257 ELECTRONS FROM SOLAR FLARES IN THE 10- TO 200-MeV REGION. Datlowe, D.; L'Heureux, J.; Meyer, P. (Univ. of Chicago). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 643-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

The emission of electrons in association with solar flares has frequently been observed at energies around 50 keV and occasionally between 5 and 10 MeV. With an instrument on board the satellite OGO-5 during 1968, solar electrons with energy in excess of 10 MeV were searched for. On several occasions an excess flux of high-energy electrons associated with solar flare activity was measured. A report is given on these observations and the energy spectra and time history for some of the events are discussed. (auth)

34258 DELAYED APPEARANCE OF RELATIVISTIC ELECTRONS 5 DAYS AFTER A SOLAR FLARE. Simnett, G. M.; Cline, T. L.; Holt, S. S.; McDonald, F. B. (Goddard Space Flight Center, Greenbelt, Md.). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 649-56(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

An analysis of interplanetary 0.3 to 10-MeV electron and proton intensities between July 6 and 16, 1968 indicates that the event had some unusual features. Comparison with solar radio, optical, and x-ray data indicate that in this case a large electron increase on July 13 was produced at the latest on July 18. Features of the solar flares from July 6 to 16 are discussed. The peak electron and 1 to 6-MeV proton intensities on July 13 show an inverse velocity dispersion: the peak electron intensity, for example, occurs 4 hours after the latest proton peak. The relative merits of several propagation models are discussed. (auth)

34259 SHORT-LIVED INCREASE IN THE CHARGED-PARTICLE FLUX AT THE EQUATOR DURING THE MAGNETIC STORM OF OCTOBER 31, 1968. Sood, R. K.; Green, C. A.; Elliot, H. (Imperial Coll. of Science and Tech., London). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 657-62(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

A 30% increase in the charged particle flux at 5 gm/cm^2 atmospheric depth was recorded during the course of a balloon flight made from near the geomagnetic equator on October 31, 1968. This increase, attributed to protons $\geq$500 MeV and/or electrons $\geq$20 MeV, started at $\approx$1030 UT and lasted for $\approx$100 minutes. It occurred during the course of a geomagnetic storm commencing at 0859 UT on the same day. In the absence of high-energy solar protons and of increases in ground level neutron monitor rates, the source of the particles is thought to be the inner radiation belt. The atmospheric dumping of particles at the time of geomagnetic storms is suggested as an important loss mechanism for the inner zone protons. (auth)

34260 EMISSION AND PROPAGATION OF $\approx$40-keV SOLAR ELECTRONS. Lin, R. P. (Univ. of California, Berkeley). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 669-77(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Since the first spacecraft observations of $\approx$40 keV solar electrons in 1965 over 130 such electron events have been detected by the essentially continuous monitoring of the IMP (Interplanetary Monitoring Platform) satellites. These impulsive $\approx$40 keV electron events are closely associated with solar flares and are the most common type of energetic solar particle emission. Studies of the relationship of these electron events to other solar phenomena, in particular solar proton and relativistic energy solar electron events, indicate that the acceleration and emission of $\approx$40 keV solar electrons is a phenomenon distinct from the production of solar protons and relativistic electrons. A close correlation is evident between $\approx$40 keV electron events and flash phase phenomena such as x-ray and radio bursts. For the small flares commonly associated with $\approx$40 keV electron events the production of such particles must constitute a major flare process. The propagation of $\approx$40 keV electrons has been studied. The transit time, rise time to maximum, and decay time all show no solar longitude dependence. These results indicate that these electrons are released over a large area of the Sun and that subsequently the propagation of these electrons can best be described in terms of a cone of propagation defined by the interplanetary magnetic field lines which thread the electron production and/or storage region at the Sun. (auth)

34261 PRODUCTION OF NEUTRONS AND GAMMA RAYS BY NUCLEAR INTERACTIONS IN SOLAR FLARES. Ito, K.; Okazoe, H. (Rikkyo Univ., Tokyo). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 679-82(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

In solar flares, it is expected that solar neutrons and 2.23-MeV gamma-rays are mainly produced by high-energy flare particles and nuclear de-excitation gamma-rays by low-energy flare particles. Therefore, even in such a small flare that flare particles may not reach the Earth, it is possible that the nuclear de-excitation gamma-rays would be detectable at the Earth. Here in addition to the flare particle rigidity spectrum of the exponential form the flare particle energy spectrum of the form $N(E)dE = (N/E_0)dE$ $(0 < E < E_0)$ is considered, the value of E_0 being 30 to 200 MeV per nucleon. The flare particles will effectively contribute to the production of nuclear de-excitation gamma-rays. The results of the calculations on neutron and gamma-ray production are also compared with the experimental data. (auth)

34262 SOLAR GAMMA-RAY BURST OBSERVED ON SEPT. 27, 1968. Hirasima, Y.; Okudaira, K.; Yamagami, T. (Rikkyo Univ., Tokyo). Acta Phys. Acad. Sci. Hung.; 29: Suppl. 2, 683-8(1970).

From eleventh international conference on cosmic rays; Budapest, Hungary (25 Aug 1969).

Balloon observation of gamma rays was made on Sept 27, 1968 at Haranomati (geomagnetic latitude 27.5°) with a phoswich scintillation spectrometer. Increase of gamma counts occurred at about 0344 UT, which was coincident with a solar radio burst at 1000 MHz. Its duration was about a minute. This event can be considered as a solar gamma burst, because of the simultaneous occurrence with the solar radio burst, and the rather high cutoff rigidity for charged particles by the geomagnetic field. Several line spectra were observed and interpreted as nuclear de-excitation gamma rays from the solar atmospheric nuclei. (auth)

34263 DEVELOPMENT AND SPATIAL STRUCTURE OF PROTON FLARES NEAR THE LIMB AND CORONAL PHENOMENA. IV. PROTON FLARE ON NOVEMBER 2, 1969 AND ITS ACTIVE REGION. Bumba, V. (Astronomical Inst., Ondrejov, Czech.); Krivsky, L.; Sykora, J. Bull. Astron. Inst. Czech.; 23: No. 2, 85-93(1972).

The proton flare on November 2, 1969, originated at about 1030 UT approximately 8 to 10° behind the west limb (N 14°). For a number of rotations there was demonstrated a large-scale development of magnetic fields around the occurrence of the proton flare as the location of the active region with the proton flare in that development. At the same time radiation from the corona was watched one rotation after another. At the critical time near the generation of the proton flare behind the limb of the disc there was in action a number of other active phenomena on the disc, which were also the source of an x-ray burst. The proton flare of the character of an ascending loop tunnel in Hα was a typical flare with a flow of fast protons. The main phase of the fast-particle flow took place at about 1030–1035 UT. On the basis of examination of flares of the same character and using other author's results one can deduce certain mechanisms of the acceleration of particles in various spaces of the complex process of the flare. (auth)

34264 DEVELOPMENT AND SPATIAL STRUCTURE OF PROTON FLARES NEAR THE LIMB AND CORONAL PHENOMENA. V. EMISSIONS AND EFFECTS OF THE PROTON FLARE AND ACTIVE PROCESSES FROM NOVEMBER 2, 1969. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.); Tlamicha, A.; Halenka, J.; (and others). Bull. Astron. Inst. Czech.; 23: No. 2, 94-104(1972).

From the character of the x-ray burst measured on satellites the maximum flux in particular channels was fixed along with the total radiated energy. The electron temperature and emission measure were calculated. The course and character of the radio activity and ionospheric effects are described. The diffusion of the particles of sub-cosmic radiation was fixed. The geomagnetic and ionospheric situations after the proton flare are described. (auth)

34265 TIME VARIATION OF X-RAY FLUX AROUND SOLAR PROTON EVENTS. Galanova, T. (Geophysical Inst., Bratislava); Pinter, S.; Krivsky, L. Bull. Astron. Inst. Czech.; 23: No. 2, 105-6(1972).

The daily changes of the solar x-ray flux in a spectral region 1 to 8 and 8 to 20 Å several days before and after a proton flare were investigated using the method of superposition of zero epochs. The results show that the soft x-ray flux increases and the maximum is at the day of the occurrence of the flare, when medium area of solar spots in the proton active region reaches the maximum value. (auth)

34266 SOLAR PHOTOSPHERIC ABUNDANCES OF PROBLEMATICAL ELEMENTS BY SPECTRUM SYNTHESIS. Boyle, Richard Patrick. Washington, D. C.; Georgetown Univ. (1972). 183p. University Microfilms Order No. 72-16,032.

Thesis.

New determinations of the solar photospheric abundances of seven heavier elements are presented: chromium, nickel, silver, erbium, ytterbium, lutetium, and thorium. Detailed line-profile calculation was used in matching the synthesized solar spectrum to the observed. Because of the serious blending of lines encountered, and the difficulties in locating the continuum, very high-resolution scans (resolution = 0.005 Å) at the center of the solar disk were made at Kitt Peak National Observatory by means of the McMath Solar Telescope. Since most of the lines were weak to medium-strong, local thermodynamic equilibrium was assumed throughout, along with van der Waals damping. The abundance results depend on the Bilderberg Continuum Atmosphere model of the Sun, although tests of other models are included. Since the observations proved so accurate (rms error less than 0.36% of the continuum level), those selected for fitting are made available in numerical form in an appendix supplementing the plotted profiles. The majority of the abundance results are judged to be of high quality, although some require caution. (TSS) (Diss. Abstr. Int., B)

34267 OPTICAL AND INNER-SHELL TRANSITIONS IN HIGHLY IONIZED Cu, Fe, AND Ti FROM A POINT PLASMA SOURCE. Elton, R. C. (Naval Research Lab., Washington, D. C.); Lie, T. N. J. Phys. (Paris), Colloq.; No. 4, 61-3(1971).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

X-ray emission originating from hydrogenic (Ti XXII) and helium-like (Cu XXVIII, Fe XXV, and Ti XXI) optical transitions as well as from innershell x-ray transitions in the ionic species Fe XIX–XXIV and Ti XV–XX was observed from a point plasma generated in a linear vacuum discharge. The wavelengths measured are compared to theoretical predictions and to some solar flare measurements. In an effort to develop a model for the generation of such species, the plasma kinetics and electron temperature and density were measured. The results indicate the existence of an axially propagating radial pinch, with at least a portion collapsing into a minute point. Thermal ionization is suggested as a mechanism for the ion production. (France)

34268 TWO-FLUID SOLAR WIND MODEL WITH ANISOTROPIC PROTON TEMPERATURE. Leer, E.; Axford, W. I. (Univ. of California, San Diego, La Jolla). Solar Phys.; 23: No. 1, 238-50(Mar 1972).

A two-fluid model of the solar wind with anisotropic proton temperature and allowing for extended coronal proton heating is considered for the case of a purely radial and of a spiral magnetic field. Proton–proton Coulomb collisions together with a spiral interplanetary magnetic field are found to be sufficient to reduce the thermal anisotropy in the proton gas to a value in agreement with observations. Reasonable values are obtained for the flow-velocity, number density and the proton temperature near the orbit of the Earth. (auth)

34269 NEUTRAL SHEETS IN THE SOLAR WIND. Pneuman, G. W. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 23: No. 1, 223-37(Mar 1972).

The structure and dynamics of neutral sheets in the solar wind are examined. The internal magnetic topology of the sheet is argued to be that of thin magnetic tongues greatly distended outward by the expansion inside the sheet. Due to finite conductivity effects, outward flow takes place across field lines but is retarded relative to the ambient solar wind by the reverse J × B force. The sheet thickness as well as the internal transverse magnetic field are found to be proportional to the electrical conductivity to the inverse one third power. Estimating a conductivity appropriate for a current carried largely by the ions perpendicular to the magnetic field, sheet dimensions of the order of 500 km are found representative for the inner solar corona. For a radial field of strength $\frac{1}{2}$G at $2R_\odot$, the transverse field there is about 2×10^{-3} G and decreases outward rapidly. The energy release in the form of Joulean dissipation inside the sheet is estimated. It is concluded that ohmic heating in current sheets is not a significant source of energy for the overall solar-wind expansion, mainly because these structures occupy only a small percentage of the total coronal volume. However, the local energy release through this mechanism is found to be large—in fact, over 7 times that expected to be supplied by thermal conduction. Therefore, ohmic heating is probably a dominant energy source for the dynamical conditions within the sheet itself. (auth)

34270 CRITICAL POINT REGULARITY CONDITIONS AND ASYMPTOTIC SOLUTIONS TO THE TIME STATIONARY, LINEARIZED, INHOMOGENEOUS SOLAR-WIND FLOW PROBLEM. Siscoe, G. L. (Univ. of California, Los Angeles); Carovillano, R. L. Solar Phys.; 23: No. 1, 211-22(Mar 1972).

The assumption of the existence of steady-state, linearized inhomogeneous solar wind flow imposes a relation between the perturbation variables such that the solutions are regular at the critical points. The critical-point regularity conditions are derived for the case of hydromagnetic flow with no rotation, for which there are two critical points, and the case of hydrodynamic flow with rotation and one critical point. It is possible that the organization imposed by the critical points is reflected in correlations observed between solar-wind parameters near the orbit of Earth. Analytic asymptotic solutions are also derived to complete the description given previously of the intermediate range flow obtained by numerical integrations. The asymptotic solutions can be described in terms of pressure waves that, in general, propagate radially with respect to the zero-order flow. The pressure perturbation for expected solar-wind conditions is found to increase with distance and the velocity perturbations to decrease. (auth)

34271 TRANSPORT OF COSMIC RAYS IN THE SOLAR CORONA. Fisk, L. A.; Schatten, K. H. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 23: No. 1, 204-10(Mar 1972).

A model is proposed to explain the transport of energetic protons in the solar corona. The particles are assumed to undergo an enhanced gradient-B drift along thin current sheets separating discontinuous field structures in the corona. These discontinuities may represent the extension into the corona of photospheric granular and supergranular cell boundaries. A quantitative analysis of this process was made by assuming that the particle propagation can be described by a diffusion equation. Comparison of predictions of the model with cosmic-ray observations at ~1 AU provides some support for the model. (auth)

34272 NEUTRALIZATION AND STABILIZATION OF PARTICLE STREAMS IN THE CORONA AND TYPE III RADIO BURSTS. Smith, Dean F. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 23: No. 1, 191-203(Mar 1972).

The processes by which streams of charged particles become charge- and current-neutralized in the corona were investigated. It is shown that a large-amplitude plasma wave, which is related to precursor phenomenon in Type-III bursts and possibly plasma radiation from Type-IV bursts, will be excited at the head of the stream. The energy extracted from the stream to produce this plasma wave was computed and used to set conservative upper limits on the densities of possible excitors for Type-III bursts. For electron streams the density $n_s < 10^{-5}\, n_e$, where n_e is the density of the background plasma. For proton streams $n_s < 1.8 \times 10^{-2}\, n_e$. The energy extracted from the stream was also used to set upper limits on the lifetimes of relativistic electrons "stored" in the corona and it was concluded that for $n_e > 10^2$ cm^{-3} this loss must be taken into account. Since electron streams cannot produce their own stabilizing ion-acoustic waves because they would violate the condition $n_s < 10^{-5}\, n_e$, other mechanisms for producing ion-acoustic waves in the corona were examined. Another stabilization mechanism due to velocity inhomogeneity was investigated. (auth)

34273 SEARCH FOR HIGH-ENERGY GAMMA-RAYS FROM SOLAR ACTIVE REGIONS. Sood, R. K. (Imperial Coll. of Science and Tech., London). Solar Phys.; 23: No. 1, 183-90 (Mar 1972).

The Elliot model for solar flares predicts weak γ-ray emission from the flare region prior to large flares. A search was made for such γ radiation of energy >50 MeV. The experiment was performed using balloon-borne detectors flown from an equatorial station during the 1967/1968 solar maximum. A number of small flares were observed, but no associated γ rays were detected. A limit of 2.3×10^4 photons/cm^2 s was placed on the emission from an importance 1N flare. The general lack of major solar activity during the period of the balloon flights precluded a test for the Elliot model. (auth)

34274 POSSIBLE LONG-PERIOD OSCILLATIONS IN SOLAR RADIO EMISSION AT MICROWAVES. Kaufmann, Pierre (Univ. Mackenzie, Sao Paulo, Brazil). Solar Phys.; 23: No. 1, 178-82 (Mar 1972).

Long-enduring bursts in the Sun at microwave frequency can occur in a succession, and rare examples of 41-min periodic structure are shown. The experimental difficulties for identifying such phenomena are discussed; their possible association with oscillations in quiescent prominences is suggested. (auth)

34275 TEMPERATURE AND EMISSION MEASURE OF THERMAL RADIO BURSTS. Shimabukuro, F. I. (Aerospace Corp., El Segundo, Calif.). Solar Phys.; 23: No. 1, 169-77(Mar 1972).

Once the area of a thermal burst region has been determined, it is possible to obtain the temperature and emission measure of the burst by examination of the flux spectrum. Such determinations were made for three events. Temperatures in the range 2 to 6×10^6 K and emission measures in the area of 2.6 to 5.4×10^{49} cm^{-3} were consistent with radio observations. Electron densities were estimated to be of the order of 1 to 5×10^{10} electrons cm^{-3}. (auth)

34276 SOFT X-RAY AND MICROWAVE OBSERVATIONS OF HOT REGIONS IN SOLAR FLARES. Hudson, H. S.; Ohki, K. (Tokyo Astronomical Observatory, Mitaka, Japan). Solar Phys.; 23: No. 1, 155-68(Mar 1972).

Hot regions in solar flares produce x radiation and microwaves by thermal processes. Recent x-ray data make it possible to specify the temperature and emission measure of the soft x-ray source by using, for instance, a combination of the 1- to 8-Å (peak response at about 2 keV) and the 0.5- to 5-Å (peak response at about 5 keV) broad-band photometers. The temperatures and emission measures thus derived satisfactorily explain the radio fluxes, within systematic errors of about a factor of 3. Comparison of 15 events with differing parameters shows that a hot solar flare region has an approximately isothermal temperature distribution. The time evolution of the correlation in a single event shows that the hot material originates in the chromosphere, rather than the corona. The density must lie between 10^{10} and 2×10^{11} cm^{-3}. For an Importance 1 flare, this implies a stored energy of roughly 2×10^{30} to 10^{29} ergs. A refinement of the data will enable one to choose between conductive and radiative cooling models. (auth)

34277 PHYSICAL MECHANISM FOR THE PRODUCTION OF SOLAR FLARES. Sen, Hari K.; White, Marvin L. (Air Force Cambridge Research Labs., Bedford, Mass.). Solar Phys.; 23: No. 1, 146-54(Mar 1972).

The weakly ionized photospheric layer in the sunspot environment satisfies certain dynamo inequalities, resulting in photospheric Hall-current systems. The corresponding Joule dissipation is associated with the surrounding plage area. For critical values of the "driving" or convective winds (speeds ≥ 1 km/s), two-stream instability results. The computed energy is of the order of that found in solar flares. (auth)

34278 REMARK ON ROTATIONAL MOTIONS IN FLARES AND PROMINENCES. Oehman, Yngve (Stockholm Observatory). Solar Phys.; 23: No. 1, 134-41(Mar 1972).

From material secured with the McMath Solar Telescope of the Kitt Peak National Observatory rotational (orbital) motion was found in a prominence ejected from a rotating flare. A period of rotation of 32 min was derived from the study of a periodic asymmetry of the Al I λ3961 absorption line. (auth)

34279 1- TO 55- A X-RAY EMISSION FROM AN ACTIVE LIMB PROMINENCE. Brinkman, A. C. (Space Research Lab., Utrecht); Shaw, M. L. Solar Phys.; 23: No. 1, 120-33 (Mar 1972).

The solar x-ray emission spectrum between 1 and 55 Å was studied for one solar event, using the two x-ray experiments onboard of the ESRO 2 satellite. Although this event fits the description of the class of x-ray events described as gradual rise and fall events, there is evidence to show that it is caused by the superposition of a number of events, of which the largest one was correlated with the appearance of an active loop-like prominence on the east limb of the Sun. By assuming the radiation processes in the source region to be thermal, temperatures and emission measures against time for the source region were derived using the most recent models for free–free continuum and line emission due to thermal plasmas. The temperatures derived were used to calculate cooling rates due to radiation losses. It is shown from data in the 2.2- to 3.0-Å band that the cooling rate of the excited corona associated with the prominence is compatible with an electron density of 1×10^{11} cm^{-3} if a single injection of particles is considered to occur in the corona. From data in the 5.8- to 8.8-Å band one finds a value of 2×10^{10} cm^{-3}. An estimate of the total injected energy is made. (auth)

34280 CORONAL EMISSION LINE POLARIZATION. House, Lewis L. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 23: No. 1, 103-19(Mar 1972).

A discussion of a program for the computation of coronal emission line polarization is presented. The starting point is a general formulation of the scattering function for magnetic dipole transitions between any two total angular momentum levels, J → J, J ± 1. Illustration of the behavior of the scattering function for different transitions is given. The integration of the scattering function over the solar disk and along the line of sight accounting for arbitrary distribution of magnetic fields as well as an inhomogeneous temperature and density structure of the corona is considered next. Sample results are presented for the numerical computation of the angle of maximum polarization and the degree of maximum polarization to be expected from idealized magnetic field configurations such as radial and dipole. A computation is included for a realistic field configuration predicted to exist at the time of the 1966 eclipse. The magnetic field input to the scattering calculation is based upon the potential field extension of photospheric magnetic fields. It is the purpose of the sample calculations to demonstrate how the measurement of emission polarization measurements can be interpreted in terms of the direction of coronal magnetic fields. Factors which lend ambiguity to such interpretations are clearly illustrated from the examples. These include the Hanle-effect depolarization and the depolarization at the Van Vleck angle. (auth)

34281 STRUCTURE OF THE CHROMOSPHERE–CORONA TRANSITION REGION. Moore, R. L.; Fung, P. C. W. (Stanford Univ., Calif.). Solar Phys.; 23: No. 1, 78-102(Mar 1972).

The structure and energy balance of the chromosphere–corona transition region was investigated by means of a static, planar model which was compared with the results of xuv-resonance-line observations. In this model, the transition region is heated by thermal conduction from the corona and cooled by radiative losses. Comparison of the model with observational results implies that this is the dominant process in the energy balance of the transition region, and that the base of the transition region is inherently nonstatic and/or nonplanar. The model explains the observational finding of Noyes et al. (1970) that the number density and the downward heat flux both increase by the same factor from quiet regions to active regions. The implications of these results are discussed with regard to spicules. (auth)

34282 PHOTOELECTRIC LINE PROFILES IN UMBRAL SPECTRA. Fay, T. D.; Wyller, A. A.; Yun, H. S. (Franklin Inst., Swarthmore, Pa.). Solar Phys.; 23: No. 1, 58-77(Mar 1972).

Umbral line profiles of Hα, NaD_2, and He I 10830 were observed photoelectrically with a pressure scanning spectrometer, URSIES (Ultravariable Resolution Single Interferometer Echelle Scanner). Intermittent pulse counting techniques were applied with integration times as short as 0.8 s, which permits selection of moments of good seeing and guiding even in poor climates. The Hα line profile shows in a medium-sized spot ($A_u = 100 \times 10^{-6}$ SH) a pronounced weakening in the wings but a persistence of the line core in agreement with the results of Fricke and Elsässer (1965). The profile of the He I 10830 line shows an unexpected strengthening over the umbra of the two spots which have been observed. The strengthening of the line in the umbral spectrum of a third spot was confirmed by Mallia at the Oxford Solar Station (Gornergrat, Switzerland). The NaD_2 line profile together with continuum observations at λ4260, λ5890, and λ6530 have been accounted for with an empirical (T, τ) relation by Yun (1971). The wavelength dependence and the absolute values from 4000 Å to 14000 Å of the intensity curve generated by this relation show very good agreement with the intensities observed by Wohl et al. (1970) in a spot of similar diameter. Precision observations of the continuum at λ5890 indicate umbra-to-disk continuum ratios that are higher (0.104) than the Mercury calibrated value by Mattig (0.086) even when a maximal correction for scattered light is applied. Only Zwaan's (1965) cool umbral model atmosphere approaches Mattig's continuum value, but this model renders the absorption wings in NaD_2 much too deep. It is suggested that future definitive observations should be carried out with coronagraphs under coronal skies or in satellites. (auth)

34283 SPECTRAL ANALYSES OF SOLAR PHOTOSPHERIC FLUCTUATIONS. II. PROFILE FLUCTUATIONS IN THE WINGS OF THE lambda5183.6 MgI b_1 LINE. Edmonds, Frank N. Jr. (Univ. of Texas, Austin). Solar Phys.; 23: No. 1, 47-57 (Mar 1972).

Residual intensity fluctuation measurements within the wings of the λ5183.6 Mg I b_1 line, obtained from two, high-resolution, high-dispersion, Sacramento Peak Observatory spectrograms, were subtracted from intensity fluctuations in the adjacent continuum in order to isolate fluctuations associated exclusively with line formation. The usable spectral range for studying these line-formation fluctuations is restricted to wavelengths between 1040 and 7170 km because the subtraction increases the relative importance of noise and large-scale photographic variations across the spectrograms that could not be completely removed. Power and cross-power (coherence and phase) spectra proved to be valuable diagnostic tools in isolating line-formation fluctuations. Over this spectral range, the line-formation fluctuations are characterized by flat power spectra as compared to those for continuum fluctuations, appreciable fluctuation rms relative to that for continuum fluctuations, and the necessity to multiply the wing fluctuations by a factor $0.95 \leq \alpha_{min} \leq 1.00$ to most effectively isolate these fluctuations. That continuum fluctuations are modified in shape but otherwise not drastically changed in the line wings explains the flat spectrum. The relative rms's vary from 0.34 in the inner wing to 0.22 in the outer. The range of possible values for α_{min} results from uncertainties in the photographic density-residual intensity calibration. (auth)

34284 MEASUREMENTS OF THE LIMB DARKENING IN THE FORBIDDEN MgI LINE AT 4571.1 A. White, O. R. (National Center for Atmospheric Research, Boulder, Colo.). ; Altrock, R. C.; Brault, J. W.; Slaughter, C. D. Solar Phys.; 23: No. 1, 18-25(Mar 1972).

High-resolution measurements of the center-to-limb variation of the Mg I line at 4571.1 Å are reported. This forbidden line is of interest because it should be formed in LTE. Comparison of the measurements with the Harvard–Smithsonian Reference Atmosphere shows that the line center radiation originates in the temperature minimum region from 330 to 550 km above the point where $\tau_{continuum} = 1$. Observations near the limb confirm that the temperature minimum is ~4200 K. (auth)

34285 INTENSITY FLUCTUATIONS IN FRAUNHOFER LINES. Orrall, Frank Q. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 23: No. 1, 30-46(Mar 1972).

An expression is derived for the fluctuation $\psi(t)$ in emergent intensity (observed at some wavelength λ in a Fraunhofer line or the continuum) caused by a perturbation in temperature $\theta(z,t)$ in the Sun's atmosphere. If the contribution function for the observed intensity is single-peaked near z_λ and if $\theta(z)$ and $p(z)$ are not too rapidly varying, then $\psi_\lambda(t) \sim M_\lambda\theta(z_\lambda,t) + N_\lambda p(z_\lambda,t)$ where M_λ and N_λ depend on the structure of the atmosphere. M, N, and contribution functions are computed for several values of μ and Δλ in the inner wings of the K line (λ3933 Ca II). (auth)

34286 SOLAR ABUNDANCE OF GOLD. Ross, John E.; Aller, Lawrence H. (Univ. of California, Los Angeles). Solar Phys.; 23: No. 1, 13-17(Mar 1972).

From 13 scans obtained with a double-band pass spectrograph at the Snow telescope at Mount Wilson, interpreted by the method of spectral synthesis, the abundance of gold turns out to be log $[N(Au)/N(H)] + 12 = 0.70$, assuming $\log gf = -0.57$. (auth)

34287 DEPENDENCE OF THE LINEAR VELOCITY OF SOLAR ROTATION ON LATITUDE AND OPTICAL DEPTH. Solonskii, Y. A. (Leningrad State Univ.). Solar Phys.; 23: No. 1, 3-12(Mar 1972).

The law of solar axial rotation was investigated by the spectroscopic method. Fayes formula, $\nu(\varphi) = 2.03 - 1.6 \sin^2 \varphi$, followed from a great number of observations (800 different values of velocity derived from an investigation of 800 spectral lines of different intensity and of different elements). The dependence of the solar rotation on the depth in the atmosphere was investigated. For this purpose the optical depths of the formation of the core of 800 spectral lines were determined. The dependence of the rotational velocity on the heliographic latitude and the depth in the atmosphere is well described by the empirical formula. The main conclusion of this investigation is the existence of an anomaly in the rotational velocity of the Sun at heliographic latitude 25°. Moreover the amplitude of the deflection of the rotational velocity at the above-mentioned latitude varies with the optical depth. (auth)

34288 NOTE ON THE CHARATERISTICS OF SUNSPOT GROUPS WHICH PRODUCE SOLAR PROTON FLARES. Sakurai, Kunitomo (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.; 23: No. 1, 142-5(Mar 1972).

Solar proton flares are associated with sunspot groups that show an unusual distribution of magnetic polarities. Furthermore, the gradient of the magnetic field is very large before the onset of these flares. The importance of polar-cap absorptions, which are proportional to the integral flux of solar cosmic rays, tends to increase as the gradient of the magnetic field becomes greater. It is shown that the formation of such gradients is associated with the rotating motion of sunspot groups. Hence, the sunspot groups which show a reversed polarity distribution are very effective for the production of solar proton flares. (auth)

34289 INFLUENCE OF LINES OF VARIOUS METALS ON THE SOLAR COLOURS. Bell, R. A. (Univ. of Maryland, College Park). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 13P-17P(1972).

Synthetic spectra calculations are used to examine the influence of lines of different metals on the solar colors. It is found that the changes in colors such as $U - B$ and $B - V$ show a relatively smooth variation as the abundances of titanium, of iron, of iron group elements and of all elements are consecutively reduced. However, more complex indices such as m_1 and c_1 of the uvby system have a more complicated variation with abundance changes. This will, for example, place limits on the accuracy of absolute magnitudes obtained from c_1. The color changes produced by abundance increases are of larger size than those produced by abundance decreases. (auth)

Galaxies

Refer also to abstract 34041.

34290 INFRARED EMISSIVITIES OF H_2 AND HD. Dalgarno, A.; Wright, E. L. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J.; 174: No. 1, L49-51(15 May 1972).

The emissivities in the pure rotational lines of H_2 and HD are calculated, and it is suggested that the lines offer a useful means of measuring the interstellar deuterium abundance. The predicted fluxes from the molecular cloud near Sgr B2 seem within the capabilities of present detectors, provided that adequate resolution can be achieved. (auth)

34291 CARBON MONOXIDE OBSERVATIONS OF DENSE INTERSTELLAR CLOUDS. Penzias, A. A. (Bell Telephone Labs., Inc., Holmdel, N. J.); Solomon, P. M.; Jefferts, K. B.; Wilson, R. W. Astrophys. J.; 174: No. 1, L43-8(15 May 1972).

Millimeter observations of the $J = 0-1$ transition of $^{12}C^{16}O$ were made in 12 dark interstellar clouds. In four of these $^{13}C^{16}O$ lines were observed at approximately one-third the intensity of the $^{12}C^{16}O$ lines. The high apparent $^{13}C/^{12}C$ ratio in carbon monoxide was due to large optical depth. Column densities of CO were about 10^{18} cm^{-2} in these clouds. Theoretical arguments are presented showing that the $J = 0-1$ transition will be thermalized and the observed flux is used to obtain kinetic temperatures. $T_{kinetic}$ was in the range 6 to 18°K, with most of the clouds near 6°K. The temperature determined by the CO agreed with earlier values obtained for two clouds by Heiles, who used OH intensities. (auth)

34292 mm-OBSERVATIONS OF THE EXPLODING GALAXY M 82. Feix, G. (Ruhr Univ., Bochum, Ger.). Astron. Astrophys.; 18: No. 3, 481-3(May 1972).

M82 was mapped at 81 GHz at a resolution of 1.2′ arc. The loop stability of solar prominences is compared with galactic prominences of M82. (auth)

34293 HIGH-VELOCITY HYDROGEN APPARENTLY ASSOCIATED WITH CONTINUUM JETS NEAR THE GALACTIC CENTER. Sanders, R. H. (Columbia Univ., New York); Wrixon, G. T. Astron. Astrophys.; 18: No. 3, 467-70(May 1972).

Observations at 21-cm of the distribution of high-velocity hydrogen near the center of the Galaxy are presented. The hydrogen distribution out of the plane is aligned along an axis which passes through the galactic center and makes an angle of about 50° with the plane. This is approximately the same axis along which are aligned two ridges of continuum radiation previously reported by Kerr and Sinclair (1966). The continuum ridges each extend about 1° from the galactic center, while the hydrogen distribution extends 4 to 5° from the center, above and below the plane. The hydrogen below the plane is seen as a distinct feature with a velocity of about −170 km/s and a velocity dispersion of about 20 km/s, while the hydrogen above the plane is seen as a ridge of enhanced emission over a broad range of velocities (from +85 km/s to +150 km/s). There is no apparent change in velocity with distance from the galactic center for either the positive or negative velocity features. Two hypotheses for the origin of these features are discussed. (auth)

34294 PROPAGATION OF RADIATION IN OPTICALLY THIN ANISOTROPIC MEDIA. Dolginov, A. Z.; Silant'ev, N. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 62: No. 1, 100-10(Jan 1972). (In Russian).

The propagation of radiation in optically thin anisotropic noncrystalline media such as interstellar space is considered. Explicit formulas are obtained for the Stokes parameters of transmitted and scattered radiation in media with various types of anisotropy. It is shown that on passage of light through a medium consisting of anisotropic oriented molecules or small particles the plane of polarization may rotate and linear polarization may change into circular or vice versa. Astrophysical phenomena in which the effects considered may be important are discussed. (auth)

34295 AGGLOMERATION OF COSMIC DUST. Trubnikov, B. A. Priroda; No. 8, 76-7(Aug 1971). (In Russian).

Safronov's model for agglomeration of cosmic particles was first announced in 1962, when it was shown that a specific spectrum of masses forms in the course of time, irrespective of the initial mass distribution of particles. In the process of agglomeration of particles a nonrotating spherically symmetrical cloud in time assumes a fixed structure in space. In the discussion reference is made to Bode's law as an empirical relationship, to the case of a rotating cloud, and to the effect of a magnetic field. (K.S.W.)

34296 INTERSTELLAR MOLECULES AND DENSE CLOUDS. Rank, D. M.; Townes, C. H.; Welch, W. J. (Univ. of California, Berkeley). Science; 174: No. 4014, 1083-1101(10 Dec 1971).

General properties of the interstellar medium are discussed. Recent findings on the large variety of molecules, including complex organic ones, discovered in interstellar space are reviewed in detail in terms of optical identification of interstellar molecules, radio molecular lines, molecules as probes of interstellar clouds, probes of isotopic abundances, probes of the radiation field, formation and disappearance of molecules, and future prospects. (W.D.M.)

34297 EJECTION OF GAS FROM ACTIVE NUCLEI OF GALAXIES. Shklovskii, I. S. (Sternberg Astronomical Inst., Moscow). Astrophys. Lett.; 10: No. 1, 5-7(Jan 1972).

The distribution of the filaments of gas in the "counter-jet" of the radio galaxy NGC 4486 shows that the motion of gas is governed by regular outer magnetic fields parallel to the rotation axis of the nucleus of this galaxy. A similar phenomenon is observed in other galaxies, i.e., NGC 5128 and NGC 1275. Such magnetic fields may originate from an interaction of magnetized clouds of relativistic particles with the interstellar medium. These clouds appear to be ejected in the direction of the rotation axis of the nucleus. The "fan jet" in NGC 4486 is explained by an activity of the equatorial regions of the nucleus. A similar activity is responsible for the halo of NGC 4486. This halo must be a comparatively flat system that has an elliptical outline due to projection effects. The phenomenon of the activity in nuclei of elliptical galaxies can be explained by accretion of gas from planetary nebulae which are constantly formed in these galaxies. It is not excluded that intergalactic gas is of secondary origin. This very hot gas can be a cause of x-ray emission from galactic clusters as has recently been observed. (auth)

34298 BERKELEY SURVEY OF HIGH-VELOCITY INTERSTELLAR NEUTRAL HYDROGEN. II. THE SECTION $|b| \geq 15°$. Dieter, N. H. (Univ. of California Berkeley). Astron. Astrophys., Suppl. Ser.; 5: No. 4, 313-67(Apr 1972).

Results of a survey of high-velocity interstellar neutral hydrogen are presented in the form of contour diagrams of antenna temperature as a function of galactic latitude and velocity. This is the second of two sections to the survey and includes observations far from the galactic plane. (auth)

34299 ASSOCIATION REACTIONS. Williams, David A. (Univ. of Manchester, Eng.). Astrophys. Lett.; 10: No. 1, 17-19(Jan 1972).

Although association reactions forming diatomic and small polyatomic molecules occur in the interstellar medium with negligible rates, it is shown here that larger molecules, containing about 10 atoms, may be formed in this way under interstellar conditions. Fairly large molecules have already been identified in the interstellar medium, and it is therefore suggested that any description of the formation of large interstellar molecules must take account of association reactions. (auth)

34300 INTERGALACTIC EXTINCTION IN THE LOCAL SUPERCLUSTER. I. SELECTIVE EXTINCTION. de Vaucouleurs, G.; de Vaucouleurs, A.; Corwin, H. G. Jr. (Univ. of Texas, Austin). Astron. J.; 77: No. 4, 285-7(May 1972).

An analysis of 566 color residuals $\delta(B - V)$ of 262 normal galaxies observed at McDonald Observatory between 1960 and 1968 indicates that galaxies close to the supergalactic plane have a significant color excess averaging +0.03 mag in the center sector (northern galactic hemisphere) and +0.01 mag in the anticenter sector. The estimated total optical depth of the Local Supercluster in its equatorial plane is 0.2 to 0.3 mag in blue light. (auth)

34301 NOTE ON MASS LOSS DURING COLLISIONS BETWEEN GALAXIES AND THE FORMATION OF GIANT SYSTEMS. Gallagher III, John S. (Univ. of Wisconsin, Madison); Ostriker, Jeremiah P. Astron. J.; 77: No. 4, 288-91(May 1972).

Stars will be liberated from the outer portions of galaxies which interact tidally. Using models based on the density distribution observed in the E1 galaxy NGC 3379, the mass loss is computed for hyperbolic collisions on an approximate but conservative basis. Binary collisions are then summed to show that large numbers of stars will be evaporated from elliptical members of dense clusters of galaxies. An estimate of $10^{12}\ M_\odot$ is obtained for the amount of material dispersed by this mechanism in the Coma cluster, and in rich very dense systems (Morgan's Type I) the large amount of tidally dispersed debris may constitute the centrally located "galaxies" designated cD systems which often dominate these clusters. (auth)

34302 DISTRIBUTION OF MASS IN THE GALACTIC NUCLEUS. Sanders, Robert H.; Lowinger, Thomas (Columbia Univ., New York). Astron. J.; 77: No. 4, 292-7(May 1972).

The near-infrared observations of the region near the galactic center by Becklin and Neugebauer were used to derive a mass model for the galactic nucleus which has the form of an inhomogeneous spheroidal distribution. This spheroid representing the galactic nucleus was combined with the Schmidt model of the galactic disk and the resulting rotation curve was calculated. This rotation curve is shown to be quite similar to the observed neutral-hydrogen rotation curve in the inner region of the Galaxy. The interpretation that the extended far-infrared source in the galactic nucleus observed by Hoffmann, Frederick, and Emery is thermal re-emission of starlight by dust particles is shown to be consistent with the derived model for stellar mass and light. Finally, the physical conditions in the very central core of the Galaxy are discussed, and it is suggested that the point source of near-infrared radiation found by Becklin and Neugebauer could be a light cusp due to stars captured in the potential of a massive condensed object ($\sim 6 \times 10^5\ M_\odot$), such as a black hole. (auth)

34303 EARLY-TYPE STARS AND THE MEAN-SQUARE ELECTRON DENSITY IN THE GALACTIC DISK. Richstone, Douglas O.; Davidson, Kris (Princeton Univ., N. J.). Astron. J.; 77: No. 4, 298-301(May 1972).

An assessment was made of the total supply of ionizing photons from hot stars, within several hundred parsecs of the Sun. The resulting photoionized H II regions probably contribute an average emission measure of the order of 5 pc cm^{-6}, through the galactic disk; this is smaller than other recent estimates. (auth)

34304 OBSERVATIONAL APPROACH TO THE PROBLEM OF SPIRAL STRUCTURE. III. Dixon, M. E.; Ford, V. L.; Robertson, J. W. (Australian National Univ., Canberra). Astrophys. J.; 174: No. 1, 17-26(15 May 1972).

The possibility of using the techniques of surface photometry to study the mechanism which produces spiral structure is examined, and a method is proposed which employs surface color $(U - B)$ as an age parameter and $(B - V)$ as an indicator of interstellar absorption. The method is tested by comparing surface colors of selected regions in the major arm of the LMC with an age parameter f based on the H-R diagrams of the regions. (auth)

34305 COLLAPSE IN GALACTIC NUCLEI. Mathews, William G. (Univ. of California, Santa Cruz). Astrophys. J.; 174: No. 1, 101-8(15 May 1972).

A time-dependent stability analysis for gas collapsing into galactic centers suggests that coherent objects much more massive than ordinary stars are likely to form. (auth)

34306 EMPIRICAL DETERMINATION OF THE STAR DENSITY IN THE GALACTIC HALO WITH THREE-COLOR-PHOTOMETRIC METHODS (IV, SA 71). Fenkart, R. P.; Wagner, R. (Univ., Basel). Astron. Astrophys.; 19: No. 1, 1-7(Jun 1972).

With the same three-color-photometric methods as in earlier halopapers (Becker, 1956; Fenkart, 1967 and 1968) the disc- and halo-populations in the direction of SA 71($b = -35°$) were separated and their density gradients were determined for different intervals in absolute magnitude. The symmetry in the star distribution of both populations, suggested for the directions to the galactic poles (Fenkart, 1969) did not seem to extend beyond these areas. (auth)

34307 INTERCLOUD H I GAS. Mebold, U. (Max-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 19: No. 1, 13-26(Jun 1972).

About 1300 21-cm line profiles, observed at $b \approx 30°$ and $0° \leqq l \leqq 360°$, were decomposed into about 2400 gaussian components. As the distribution of the component areas vs. velocity dispersion s shows two clearly separated peaks at $s \approx 3$ km/s and $s \approx 10$ km/s, the emission components can be divided into two classes: narrow components with $1 \lesssim s \lesssim 4$ km/s and $10 \lesssim T_{b\,max} \lesssim 50°K$ and shallow ones with $5 \lesssim s \lesssim 17$ km/s and $3 \lesssim T_{b\,max} \lesssim 10°K$. The radial velocities v_r of both types of components show a $\sin 2(l - l_1)$ variation ($l_1 \approx 19°$) with galactic longitude l. For the shallow components a $\sin^2 2(l - l_2)$ variation ($l_2 \approx 26°$) of the square of the velocity dispersion s^2 was detected. If the latter effect is due to the line broad broadening effect of differential galactic rotation, the corresponding gas is a widely distributed "intercloud" gas. From the observed amplitudes of the sin 21-variation of v_r and the $\sin^2$ 2 l-variation of s^2 and from the mean area under the shallow components a density distribution of the intercloud H I gas perpendicular to the galactic plane can be derived in the form $n(z) = (0.20 \pm 0.06) \exp \{-(|z|/(210 \pm 70)pc)^{0.94 \pm 0.23}\}\ cm^{-3}$. An observed increase of the width of the intercloud emission components from $b = 90°$ to $b \approx 20°$ is consistent with the latitude dependence of the line broadening effect of differential galactic rotation. After deconvolving for this effect the average velocity dispersion of the intercloud H I gas becomes about 8.8 km/s. This corresponds to a kinetic temperature of about 9400°K, if the line width is purely due to thermal gas motions. (auth)

34308 KINEMATIC DISTRIBUTION OF GALACTIC NEUTRAL HYDROGEN. Burton, W. B. (National Radio Astronomy Observatory, Charlottesville, Va.). Astron. Astrophys.; 19: No. 1, 51-65(Jun 1972).

The shape of neutral-hydrogen line profiles is very sensitive to the sort of irregularities in the galactic velocity field which are known to exist. By assuming that all profile structure has a kinematic origin, information can be gained about both galactic kinematics and the hydrogen distribution. With a uniform hydrogen distribution, n_H, a model profile can be fit to each observed profile by perturbing the line-of-sight velocity field from the basic Schmidt-type circular-rotation velocity field. The difference between the perturbed and basic line-of-sight velocity fields, $V_p - V_0$, is interpreted in terms of galactic kinematics. This method is being applied to two sets of line profiles of the experimental region $90° \leqq l \leqq 120°$, $b = 0°$. (W.D.M.)

34309 PHASE TRANSITION IN THE INTERSTELLAR MEDIUM. Biermann, P.; Kippenhahn, R.; Tscharnuter, W.; Yorke, H. (Univ., Goettingen, Ger.). Astron. Astrophys.; 19: No. 1, 113-22(Jun 1972).

Hot interstellar matter heated by cosmic rays is forced out of thermal equilibrium by a spiral-arm density wave. This process has been followed by a simple numerical model of thermal evolution. The transition to the cool stable cloud phase may occur within 10^6 years. Thus stars may be formed within approximately 5×10^6 years after the matter has passed through the spiral-arm density wave. This agrees with the determination of this time in M 51 by Mathewson et al. (1971). (auth)

34310 MODELS OF THE INTERSTELLAR GAS. Jura, Michael Alan. Cambridge, Mass.; Harvard Univ. (1971). 195p. University Microfilms Order No. 72-15,059.

Thesis.

A detailed investigation of the modes of energy loss of a fast electron absorbed in helium, atomic hydrogen and molecular hydrogen was carried out that considered the discrete nature of the excitation processes. The response of helium, atomic hydrogen, and molecular hydrogen to bombardment by x rays and by cosmic rays was calculated. The cooling efficiencies of the heated gases were calculated and used in construction of steady-state and time-dependent models of the interstellar medium. It is shown that a time-dependent model that assumes an x-ray burst or an ultraviolet burst with additional heating can reproduce the observed gross properties of the interstellar gas. Detailed predictions were made for hydrogen-to-helium radio-recombination line ratios, infrared-emission line strengths, and ultraviolet absorption lines in the interstellar gas. (Diss. Abstr. Int., B)

34311 DENSITY WAVE MODEL OF THE INNER PARTS OF THE GALAXY. Basu, B. (Jadavpur Univ., Calcutta); Roy, A. K. Bull. Astron. Inst. Czech.; 23: No. 2, 117-23(1972).

The density-wave model of the spiral structure was extended to the inner parts of the Galaxy. Angular velocities from Schmidt's model were used beyond 3 kpc from the center. Inside of that distance, lower values were adopted, less steeply rising towards the center. Taking the value of 20 km sec^{-1} kpc^{-1} for the angular velocity of the pattern, other galactic parameters were calculated over the entire inner region of the Galaxy. These values were used to calculate the values of the basic density. The amplitudes of the density and potential perturbation, the amplitudes of the radial and tangential velocity perturbation, and the radial velocity dispersion, in gas and stars separately, over the entire Galaxy. The radial velocity dispersion of stars at 4 to 5 kpc from the center, as given by the theory, indicates that Toomre's criterion for the stability of the galactic disc in that region is not satisfied. The amplitudes of the radial and tangential velocity perturbations obtained for the central region of the Galaxy seem to give a satisfactory explanation of the observed facts of (a) the general outward flow of gas in that region, (b) the decreasing outward velocity with increasing distance from the center, and (c) the smaller rotational velocities in regions of higher radial velocities. The model suggests that the structure of the galactic disk with regard to the location of the gaseous arms, as outlined on the assumption of the circular velocity model, requires a re-evaluation for the necessary modification. (auth)

34312 STRONG POLARIZATION SHOCKS IN THE INTERSTELLAR SPACE. Liu, V. C.; Bastos-Netto, D. (Univ. of Michigan, Ann Arbor). Phys. Lett.; 39A: No. 4, 305-7(22 May 1972).

Structure of infinitely strong shocks in a slightly ionized gas, suitable for the interstellar H I region, is discussed. The charge-separation field, in closed form, is obtained by using a bi-modal (beam-continuum) distribution and the Mott–Smith approach. (auth)

34313 DISTRIBUTION OF ANGULAR MOMENTA OF GALAXIES. Reinhardt, Michael (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 151-63(1972).

Available observations of position angles and axial ratios of galaxies are discussed. There are statistically significant departures from the distributions corresponding to a random distribution of angular momenta, and there is evidence that these departures cannot be ascribed to selection effects. Connections between the distribution of angular momenta in aggregations of galaxies and of the aggregations as a whole are indicated. Methods in preparing catalogues of position angles and axial ratios are discussed. (auth)

34314 LOW FREQUENCY, HIGH RESOLUTION OBSERVATIONS OF VIRGO A. Wilkinson, P. N.; Peckham, R. J. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc.; 156: No. 2, 7P-12P(1972).

Observations are reported of the angular structure of the central region of Virgo A at 151 and 408 MHz which complement those obtained by synthesis techniques at higher frequencies. The radio counterparts of the jet and counter-jet are shown to have different substructures at these low frequencies. The probable low-frequency cutoff in the spectra of these components is unlikely to be due to synchrotron self-absorption in compact subcomponents. (auth)

Cosmology

Refer also to abstracts 34610 and 34735.

34315 PERIODIC MODEL OF THE EVOLVING UNIVERSE. Zaikov, R. G. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 10, 1301-3(1971).

Starting from Einstein's static solution of his extended field equations for the closed Universe, a periodic model of the evolving Universe is developed. (W.D.M.)

34316 POSSIBLE LINE FEATURE IN THE X-RAY BACKGROUND. Tinsley, Beatrice M. (Univ. of Texas, Dallas). Astrophys. Lett.; 10: No. 1, 31-5(Jan 1972).

The effects of cosmological redshift and galactic evolution on Silk's (1971) theory of the x-ray background due to young pulsars in supernova remnants were evaluated, including the possible line feature near 7 keV due to K-line photons from iron-group elements. For any plausible cosmological time scales, galactic ages, and pulsar parameters, the strength of the redshifted continuum radiation from the supernova shells is found to obscure the redshift-smeared line feature in the background spectrum, so that the feature is probably undetectable. This result is insensitive to the choice of models for cosmology and galactic evolution, and holds even if the past supernova rate per unit galactic mass were the same as the present rate in our galaxy. (auth)

34317 TEST OF THE EXPANDING UNIVERSE POSTULATE. Geller, M. J.; Peebles, P. J. E. (Princeton Univ., N. J.). Astrophys. J.; 174: No. 1, 1-5(15 May 1972).

The effect of an expansion of the Universe, as opposed to a tired-light effect for the cosmological redshift, may be apparent in the available observational data. (auth)

34318 GALAXY FORMATION FROM PRIMEVAL UNIVERSAL TURBULENCE. Dallaporta, N.; Luccin, F. (Univ., Padua). Astron. Astrophys.; 19: No. 1, 123-34(Jun 1972).

The problem of galaxy separation from the continuous matter background due to density fluctuations is reconsidered in the frame of the universal turbulence theory of primeval matter, following the general outline to the problem due to Ozernoi et al. In common with these authors, the principal omission consists in the neglect of the dissipative effects occurring in the turbulence. The main behavior of the three border lines limiting the largest or external scale (line E), the smallest or internal scale (line I) of the turbulence, and representing the equality of the turbulence velocity with sound velocity (line S) is followed throughout the three main phases of the Universe; the radiation Universe phase; the ionized matter Universe phase; and the neutral matter Universe phase. (W.D.M.)

34319 MODERN COSMOLOGY. Sciama, D. W. New York; Cambridge University Press (1971). 218p. $8.95.

The major components of the Universe are described: the stars, galaxies, radio galaxies, and quasars. The redshift of the lines in their optical spectra is discussed in detail. The possibility that intergalactic space may contain a significant quantity of matter and be the seat of important physical activity is thoroughly debated. The discovery and significance of the 3°K cosmic microwave radiation, its relation to the hot big bang and the helium problem, to cosmic high-energy processes, and to questions of isotropy are discussed. (W.D.M.)

34320 GRAVITATIONAL INSTABILITY IN FRIEDMANN COSMOLOGIES. Burke, John Robert. Cambridge, Mass.; Harvard Univ. (1971). 104p. University Microfilms Order No. 72-15,054.

Thesis.

An analysis of the stability of Friedmann cosmological models against the development of density fluctuations is given in quasi-harmonic coordinates. These coordinates are chosen because the resulting form of the field equations is strongly analogous to the equations governing stability in the Newtonian approximation. Similar solutions are performed in outline for other choices of coordinate conditions in order to study the covariance properties of the results; several peculiarities arise which are related to the non-Newtonian character of the coordinate systems. The algebraic expressions for scalar quantities are shown to depend on the choice of coordinate frame due to a choice of gauge conditions on the potentials which is imposed by the method of solution. (Diss. Abstr. Int., B)

34321 PERTURBATIONS IN ANISOTROPIC EUCLIDEAN-HOMOGENEOUS COSMOLOGIES. Perko, Tapani Elias. Austin, Tex.; Univ. of Texas (1971). 90p. University Microfilms Order No. 72-15,813. Thesis.

The role of anisotropy in the early stage of the Universe is considered. The first order Fourier-analyzed perturbation calculation is carried out in a Bianchi Type-I, anisotropic homogeneous cosmology filled with perfect fluid. In particular, dust-like perturbations are considered. Approximation methods and computer calculations are used to find the growth rate of a relative density fluctuation. In a certain direction this growth rate can obey a power law as high as $v^{2/3}$ (v being the spatial volume element) in contrast to the $v^{1/3}$ growth rate in the isotropic case. However, there are also directions in which the growth rate is very low. This uneven growth rate complicates the question of condensation of matter into galaxies but is a feature lacking in the isotropic case. In common with the isotropic case is the difficulty of creating galaxies from random perturbations, the difficulty being due to the power-law growth rate. The essential problem in creating galaxies therefore is the origin of initial perturbations and the communication gap in the early Universe. The coupling between waves and density perturbations, however, offers a new way to introduce fluctuations in the matter field. Gravitational waves are studied in detail. An isotropic approximation for free waves is derived as well as an expression for the energy carried by the waves, and it is found that the strongest redshift is in the direction of the largest horizon distance. (Diss. Abstr. Int., B)

Planetary Phenomena

34322 ULTRATRACE ANALYSIS FOR BERYLLIUM IN TERRESTRIAL, METEORITIC, AND APOLLO 11 AND 12 LUNAR SAMPLES USING ELECTRON CAPTURE GAS CHROMATOGRAPHY. Eisentraut, Kent J.; Griest, Deborah J.; Sievers, Robert E. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Anal. Chem.; 43: No. 14, 2003-7(Dec 1971).

From seventh international chromatography symposium; Las Vegas, Nev. (29 Nov 1971).

A rapid and sensitive method was developed and applied to the ultratrace analysis for beryllium in terrestrial, meteoritic, and lunar samples using electron-capture gas chromatography. Beryllium was determined in lunar rock and dust samples returned from the Apollo 11 and 12 sites. The technique was also used to determine the amount of beryllium present in some U. S. Geological Survey standard rock samples, a sample of the titanium-rich Buddington's Brown Point gabbro, and samples of the Allende, Murchison, and St. Severin meteorites. In addition, a method is reported for the analysis for beryllium rocket exhaust contamination in soil. This research has revealed an interesting phenomenon regarding the concentration of beryllium in the lunar samples. The beryllium content of the lunar dust is much higher than that of any of the lunar crystalline rocks analyzed. The concentration of beryllium in the crystalline rocks is less than 1 ppM while lunar dust contains as much as five times more beryllium. The detection limit is approximately 4×10^{-14} gram beryllium; the sensitivity of the electron capture detector to beryllium trifluoroacetylacetonate is much greater at higher carrier gas flow rates. (auth)

34323 HIGH-TEMPERATURE PROTOPLANETIC PROCESSES: PROBLEM OF FORMATION OF METALLIC CORES OF PLANETS. Vinogradov, A. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya; No. 11, 1283-96 (Nov 1971). (In Russian).

The problem of the formation of metallic cores in planets of the terrestrial type is considered. It is shown that of all existing theories for the formation of metallic cores in planets the most valid is the hypothesis on condensation growth of the iron–nickel core from a cooling plasma cloud of solar composition. It has been established that the distribution of chemical elements over the phases being condensated (iron and silicate phases) is controlled by the partial oxygen pressure in the Fe –O system. (auth)

34324 ELEMENTAL ANALYSIS OF APOLLO 15 SURFACE FINES USED IN BIOLOGICAL STUDIES IN THE LUNAR RECEIVING LABORATORY. Johnson, P. H.; Walkinshaw, C. H.; Martin, J. R.; (and others) (Manned Spacecraft Center, Houston, Tex.). Bioscience; 22: No. 2, 96-9(Feb 1972).

The mineral and elemental analysis of the Apollo 15 biological sample composed of surface fines 15271(36.4%), 15301(33.7%), and 15601(29.9%) is presented. Elemental analyses of Apollo 12 and 14 biopooled samples are given for comparison. As a further index of the agricultural potential of these samples, analyses of water and acid extracts are presented. (W.D.M.)

34325 DECAMETRIC RADIO EMISSION FROM JUPITER. Cavaliere, A. (Massachusetts Inst. of Tech., Cambridge); Speranza, A. Astrophys. Lett.; 10: No. 1, 9-12(Jan 1972).

A new model for the control of the Jovian decametric radio emission by Io is proposed. The geometry of the model is based on the presence of two "surface" sources on the planet, emitting independently of Io and modulated by the passage of Io. When Io sweeps past the sources, streams of particles associated with the lines of force passing through the satellite interact with the plasma waves in the primary sources, thus altering the direction, the time structure, the brightness, and the maximum frequency of the emission received at Earth. (auth)

34326 PHOTOELECTRON EMISSION FROM Io AS THE CAUSE OF ENHANCEMENTS OF THE JOVIAN DECAMETRIC RADIATION. Mozer, F. S. (Univ. of California, Berkeley); Bogott, F. H. Astrophys. J.; 174: No. 1, 153-6(15 May 1972).

A theoretical explanation for the dependence of the Jovian decametric radiation on the position of its satellite Io is advanced in terms of electrostatic instabilities created by injection into the hot natural plasma of cold photoelectrons from Io. This may be tested with appropriately positioned and presently planned deep-space probes that search for variations of the Jovian decametric radiation at times following local sunset and sunrise at Io. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric

Refer also to abstract 34039.

34327 (AD–722042) ELECTRON CONTENT MEASUREMENTS AND F REGION MODELING APPLIED TO IONOSPHERIC PARAMETER DETERMINATION. Smith III, F. L. (Colorado State Univ., Fort Collins. Dept. of Electrical Engineering). Mar 1971. 60p. (AFCRL–71-83). NTIS.

The theory relating the ionospheric electron content to electromagnetic propagation effects along transionospheric paths is reviewed, and measurements of the diurnal variation of the electron content are presented. The possibility of using continuous electron content measurements to determine basic F-region parameters, such as ionization and recombination rates, as well as to explain anomalous features of F-region behavior is discussed. An appendix contains graphical and numerical presentations of electron content values derived from observations of vhf transmissions from the ATS-I satellite between October 1, 1968 and December 31, 1969. (auth) (NTIS)

34328 (AD–735090) SATELLITE SURVEY OF VECTOR ELECTRIC FIELDS IN THE IONOSPHERE AT FREQUENCIES FROM 10 TO 500 Hz. I. ISOTROPIC, HIGH-LATITUDE, LOW-FREQUENCY EMISSIONS. Kelley, Michael C.; Mozer, Forrest S. (California Univ., Berkeley. Space Sciences Lab.). 17 Dec 1972. Contract N00014-69-A-0200-1015. 51p. NTIS.

Vector electric fields in the frequency range from 10 to 500 Hz were measured on the 400-km polar orbiting OV1-17 satellite. Two distinct wave modes were observed on every orbit and thus are characteristic of the ionosphere at 400 km. (NTIS)

34329 (AD–735092) SATELLITE SURVEY OF VECTOR ELECTRIC FIELDS IN THE IONOSPHERE AT FREQUENCIES FROM 10 TO 500-Hz. III. LOW-FREQUENCY EQUATORIAL EMISSIONS AND THEIR RELATIONSHIP TO IONOSPHERIC TURBULENCE. Kelley, Michael C.; Mozer, Forrest S. (California Univ., Berkeley. Space Sciences Lab.). 17 Dec 1972. Contract N00014-69-A-0200-1015. 24p. NTIS.

Occasional observations of intense low-frequency electric-field fluctuations have been detected near the magnetic equator by the vector ac electric-field experiment performed on the OV1-17 satellite that was in a circular polar orbit at an altitude of about 400 km. The observed fluctuations are correlated with spread F at an equatorial ground station located near the projection of vehicle trajectory. This correlation suggests that the ionospheric electric-field turbulence is related to the modification of the propagation of radio waves resulting in scattering of the radio signals from irregularities of the medium. The polarization, intensity, and spectral characteristics of the signal are similar to the high-latitude low-frequency electric fields detected on every orbit of OV1-17. (auth) (NTIS)

34330 (N–72-14363) AIRBORNE AURORAL DATA AND SATELLITE DATA ANALYSIS. Final Report. Mende, S. B.; Eather, R. H. (Lockheed Missiles and Space Co., Palo Alto, Calif. Lockheed Palo Alto Research Lab.). Oct 1971. Contract NAS2-6299. 94p. (NASA-CR–114379). NTIS.

The photometric data taken during the 1969 CV990 expedition were analyzed. It was found that the so-called soft auroral zone extends right through the night-side auroral zone. The soft precipitation is a permanent feature of the night-side auroral zone and probably signifies the position of the plasma sheet. The harder auroras, which include the conventional visible auroras, occur less frequently. The intensity and mean energy of auroral electrons are correlated, suggesting that the fluctuation in auroral intensity comes primarily from the variability of the acceleration mechanism rather than the variations in the particle population densities. During the 1969 CV990 expedition, coordinated data were taken with the particle experiments on OV1-18 and ATS-5 satellites. The satellite data were reduced to facilitate coordinated investigations with the airborne experimenters. The airborne photometric N I 5200-Å data were analyzed, and the effective life time was found to be 4.5 minutes. (auth) (STAR)

34331 (RISO–250, pp 177-84) WAKE BEHIND A BODY IN MOTION IN A PLASMA PARALLEL TO THE MAGNETIC FIELD. Theoretical Solution. Schmitt, J. P. M. (Ecole Polytechnique, Paris (France). Laboratoire de Physique des Milieux Ionises). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (2 Sep 1971).

The original work of Al'pert et al. [Space Physics with Artificial Satellites, Consultants Bureau, New York, (1965)] for the wake behind a body in motion in a plasma is extended to include the effects of a parallel ion temperature and electric field. In addition, the effects produced when the cross-sectional area of the body is made to vary periodically in time are considered. It is found that the spatial oscillations are damped by the thermal motion of the ions, and that the spatial period of the wake is shorter than that given by the purely ballistic treatment of Al'pert et al. The electric field leads to a coupling of the wake with parallel ion acoustic waves and with perpendicular ionic Bernstein modes, which was studied in the linear approximation. The modulation of the cross-sectional area produces "magneto ballistic pseudowaves" which propagate along the ion trajectories. (auth) (Denmark)

34332 (TRITA-EPP–71-29) DETERMINATION OF IONOSPHERIC DENSITY AND TEMPERATURE USING A DOUBLE PROBE ELECTRIC FIELD DETECTOR. Pedersen, A.; Fahleson, U.; Faelthammar, C.-G. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). 17 Jun 1971. 19p. (CONF-710615–4). Dep. NTIS (U. S. Sales Only).

From fourteenth COSPAR meeting; Seattle, Wash. (17 Jun 1971).

A number of double-probe experiments for measurements of electric fields have been flown on sounding rockets the last few years. In principle, the measurements are made by measuring the potential difference between two symmetric Langmuir probes. A probe system of this type can also be used for studies of plasma parameters, such as density and temperature, in addition to the electric-field measurements. Temperature and density information obtained from two rocket flights from ESRANGE (65.3°N geomagnetic latitude) is presented. (auth) (Sweden)

34333 INVESTIGATION OF THE PHYSICS OF DYNAMICAL PROCESSES IN THE TOPSIDE F REGION. Carpenter, Lynn Allen. Urbana, Ill.; Univ. of Illinois (1971). 226p. University Microfilms Order No. 72-12,115.

Thesis.

Thomson scatter and transport processes in a plasma are described, after which the technique for determining plasma drifts is developed. Observations at altitudes between 450 and 750 km are used to construct a description of the behavior of the ionosphere. Seven 24-h operations in 1968 are examined in detail, and grouped as late summer, equinox, winter, and disturbed conditions. The diurnal behavior of the vertical velocity is studied as well as the short-period fluctuations in this vertical velocity that are superposed on the diurnal behavior. These fluctuations occur during about 30% of the observations and are attributed to traveling ionospheric disturbances. These vertical transport processes are examined for midlatitude and compared with the measured vertical velocity. The diurnal variation and altitude variation of these processes are used in assessing their relative effect during different times of day. Fluxes are determined from these vertical velocities that have a magnitude of 10^8 cm^{-2} sec^{-1}, which is an order of magnitude greater than the limiting flux calculated by several authors. The continuity equation is applied, knowing the divergence of the flux and the rate of change of electron density to determine the production and loss of ionization. The ionosphere–plasmasphere coupling and the maintenance of nighttime ionosphere are examined. (Diss. Abstr. Int., B)

34334 INFLUENCE OF FIELD FLUCTUATIONS UPON THE MEASUREMENT OF SLOWLY VARYING ELECTRIC FIELDS IN THE OUTER IONOSPHERE AND IN THE MAGNETOSPHERE. Grabowski, Reinhard (Arbeitsgruppe fuer Physikalische Weltraumforschung, Freiburg i. B.). Planet. Space Sci.; 20: No. 4, 571-9(Apr 1972).

Different thermodynamic density fluctuations of positively and negatively charged components in a plasma cause a fluctuating charge separation and fluctuating electric fields that produce a noise level in a measuring device. This noise level marks the limit below which a measurement of eventually existing macroscopic fields is not possible. An expression given by Rostoker (1961) for the joint probability of the fluctuating electric fields is used as the starting point. The mean square of the fluctuating voltage impressed on a thin straight antenna by the fluctuations in the surrounding plasma is derived. An expression is obtained that is formally equal to the well-known Nyquist formula for the resistance noise. (auth)

34335 TIME-DEPENDENT BEHAVIOUR OF A STABLE AURORAL RED ARC EXCITED BY AN ELECTRIC FIELD. Roble, R. G.; Dickinson, R. E. (National Center for Atmospheric

Research, Boulder, Colo.). Planet. Space Sci.; 20: No. 4, 591-605(Apr 1972).

The electric field hypothesis is examined as a possible explanation of a stable auroral red arc. An electric field perpendicular to the geomagnetic field in the ionosphere heats the ambient F-region electrons and ions. Given large enough electric fields, the electrons can be heated sufficiently to excite the OI (^{1}D) term of atomic oxygen by electron impact, giving rise to the λ6300 emission characteristic of the red arc. The electron and ion heating rates are determined by the relative drift between the plasma and neutral gas. The electric field, acting through ion drag, accelerates the neutral gas in a time scale small compared to the observed lifetime of the arc. If the electron density within the red arc is high, the relative drift between the plasma and neutral gas is significantly reduced and the red arc excitation is effectively shut off because of the consequent lower electron and ion heating rates. For low electron densities, the electric-field strength necessary to excite the red arc is far greater than any fields which have been observed. For all electron densities between these two extremes, the calculated features of a red arc excited by a perpendicular electric field cannot be made consistent with both satellite observations of electron temperature and ground-based observations of λ6300 emission. It is concluded that it is not possible for a perpendicular electric field to excite a red arc such as observed, and thus support the contention that conduction of heat in the electron gas from the magnetosphere alone is sufficient to excite and maintain the stable auroral red arc. (auth)

34336 OBSERVATION OF GRAVITY WAVES IN THE NIGHTTIME F-REGION. Butcher, E. C.; Joyner, K. H. (La Trobe Univ., Bundoora, Australia). Planet. Space Sci.; 20: No. 4, 613-6(Apr 1972).

Observations of gravity waves in the nighttime F-region are reported, using the method of measuring the continuous change in the phase—path length of a highly stable cw signal reflected obliquely from the ionosphere. The phase of the 4.5-MHz standard frequency transmission from VNG Lyndhurst, Victoria (lat 38°3.3′S, long. 145°15.7′E geographic), which is transmitted between approximately 1945 and 0730 local time, was compared with the phase of a highly stable local oscillator situated at a ground distance of about 40 km (lat 37°43.5′S, long. 145°03.3′E). The phase-height variations on two consecutive nights are shown, due allowance having been made of the natural frequency difference between the two oscillators. These plots show no significant evidence for the existence of gravity waves, but if the phase change measured in unit time is plotted, a marked oscillation is observed. It is shown that these marked oscillations may only correspond to slight inflections in the phase-height curves. It is noted that the phase height reaches a maximum at the same time on each night (~2330 local time and that the period of the oscillation prior to the attainment of this maximum is significantly higher than the period afterwards. It is felt that this is consistent with other results. (UK)

34337 TOPSIDE IONOSPHERE DISTURBANCE EFFECTS DURING DIFFERENT PHASES OF TWO SUCCESSIVE MAGNETIC STORMS IN SEPTEMBER 1963. Fatkullin, M. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Planet. Space Sci.; 20: No. 4, 627-36(Apr 1972).

Using the data obtained by means of the Alouette-1 satellite, the distribution of electron density in the region of the F2-layer maximum and topside ionosphere during different phases of two successive magnetic storms on September 13 and 16, 1963 was studied. The middle latitudes at local near noon and midnight hours were mainly considered. It is shown that the daytime topside electron density at some altitudes did not change during the main phases of the two magnetic storms. The electron density decreases below these levels and increases above. During the recovery phases of both magnetic storms the increase in electron density remains at all altitudes from h_mF2 to 1000 km. (auth)

34338 DIURNAL VARIATION OF ATOMIC HYDROGEN IN THE THERMOSPHERE. Wallace, L.; Strobel, D. F. (Kitt Peak National Observatory, Tucson, Ariz.). Planet. Space Sci.; 20: No. 4, 521-31(Apr 1972).

The diurnal variation of atomic hydrogen concentrations in the thermosphere is calculated from the time-dependent continuity and diffusion equations for a range of exospheric temperatures using Jacchia's formulation for the thermal and density structure of the background atmosphere. The magnitude of this variation at the critical level is similar to that obtained by approximate methods, but the details are very different. The diurnal behavior of atomic hydrogen at the critical level is insensitive to the conditions near the turbopause. As a consequence disturbances at the critical level are largely damped out when they reach the turbopause. (auth)

34339 WORLD-WIDE ELECTRON DENSITY CHANGES AND ASSOCIATED THERMOSPHERIC WINDS DURING AN IONOSPHERIC STORM. Obayashi, Tatsuzo (Tokyo Univ.). Planet. Space Sci.; 20: No. 4, 511-20(Apr 1972).

Global changes in the ionospheric electron density associated with a geomagnetic storm of June 15 to 21, 1965 are studied, using data of thirty ground-based ionospheric sounders and of Alouette-I satellite. $\Delta N_m/N_m$ at the F2 peak level and $\Delta N_s/N_s$ at the satellite level are mapped on L-value vs storm-time diagrams. Following the onset of the storm, a large positive region of $\Delta N/N$ appears in middle and low latitudes, while a negative region exists first in high latitudes and spreads over the entire globe during the main to recovery phases. In the earlier phases of the storm, the border of the positive and negative regions is found to be located near the position of the plasmapause, which is inferred from whistler data. It moves coherently with the plasmapause position towards lower L-values as the geomagnetic storm progresses. A theory is proposed to explain this characteristic of ionospheric storms in terms of thermospheric winds generated across the plasmapause. (auth)

34340 UPPER ATMOSPHERE AS A REGULATOR OF SUBAURORAL RED ARCS. Chandra, S. (Goddard Space Flight Center, Greenbelt, Md.); Maier, E. J.; Stubbe, P. Planet. Space Sci.; 20: No. 4, 461-72(Apr 1972).

The mechanisms for producing a subauroral red arc (SAR arc) are studied by solving a system of basic ionospheric and atmospheric equations. It is shown that many of the observed features of a SAR arc can be explained within the framework of the two processes generally responsible for the ionospheric behavior during a magnetic storm: these are energy conduction from the magnetosphere to the ionosphere and the changes in neutral composition of the lower atmosphere caused by the increase in turbulent mixing. Both the processes trigger a complex chain of events which ultimately results in the redistribution of both the charged and neutral particles, an increase in the electron, ion, and neutral temperatures, and a decrease in the electron density in the altitude region near the F2 peak. It is shown that both the occurrence and the emission intensity of a SAR arc are regulated by the neutral atmosphere, even though conduction of the thermal energy from the magnetosphere to the ionosphere provides the excitation energy of the optical remission. Recent satellite measurements of the ionospheric parameters have confirmed the validity of these findings and have provided grounds for rejecting several other theories which have been proposed in the literature. (auth)

34341 DENSITY VARIATIONS IN THE EXOSPHERE FROM JUNE 1968 TO DECEMBER 1970. Cook, G. E. (Royal Aircraft Establishment, Farnborough, Eng.). Planet. Space Sci.; 20: No. 4, 473-82(Apr 1972).

Two satellites, Calsphere (1964—63C) and Dodecapole (1965—16G), were used to determine weekly mean values of atmospheric density at heights near 1070 and 900 km respectively, between June 1968 and December 1970. Both satellites have nearly circular orbits and are therefore ideal for studying long-term variations in the atmosphere. After correcting the values of density to both a fixed height and a fixed level of solar activity, it is possible to trace for the first time the progress of the semiannual variation in the exosphere over 2½ years of high solar activity. The semiannual variation in density is large, with the average value for the ratio of the October maxima to the July minima being about 2. When the results are combined with earlier data from Echo 2 there is evidence of a strong oscillation in the amplitude with a periodicity of 3 years. (auth)

34342 DEVELOPMENT OF INSTABILITY IN AURORAL PLASMA AND DUMPING OF PARTICLES. Men'shutina, I. N.; Pudovkin, M. I. Cosmic Res. (USSR) Engl. Transl.); 9: No. 5, 670-5(Sep-Oct 1971).

Translated from Kosm. Issled.; 9: No. 5, 729-35(Sep-Oct 1971).

The variation of the pitch-angle distribution function in response to motion through an inhomogeneous magnetic field is examined. The variation of the distribution function is demonstrated to be describable in terms of variations of the parameter α, which increases as the plasma moves through a stronger magnetic field. The results are applied to discussion of the development of an instability resulting from temperature anisotropy in the magnetospheric plasma. The development of this mode of instability acts to equalize the temperatures and to increase the likelihood of particles ending up in the loss cone. A formula is derived for the critical particle density in terms of α and T. The instability due to temperature anisotropy is shown to set in only at certain distances where the condition $N \geq N_{cr}$ prevails. Calculations for several initial values α_0, $T_{||0}$, N_0 show that the development of this mode of instability can be accounted for in terms of dumping of particles and displacement of the circumpolar boundary of the polar aurorae toward the North Pole during magnetic activity increase. (auth)

34343 SOME PARAMETERS OF THE IONOSPHERE AND NEUTRAL ATMOSPHERE MEASURED FROM THE MR-12 ROCKET PROBE ON MARCH 30, 1968. Klyueva, N. M.; Pokhunkov, A. A.; Chasovitin, Yu. K. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 5, 676-9(Sep-Oct 1971).

Translated from Kosm. Issled.; 9: No. 5, 736-40(Sep-Oct 1971).

Height distributions of the principal components and of the temperature of the neutral atmosphere, the electron density, and the electron temperature were determined simultaneously, and analyzed, as a result of the March 30, 1968 rocket-probe experiment. From the experimental data, estimates were made of the rate of heat input to the electron gas at different heights. The calculations showed that there must exist, in addition to shortwave ionizing solar radiation, some additional sources of electron heating in the region of 130 km and below. (auth)

34344 COMPOSITION OF THE EARTH'S IONOSPHERE AT HEIGHTS OF 220 TO 4360 km FROM MEASUREMENTS ON THE VERTICAL SPACE PROBE. Ershova, V. A.; Sivtseva, L. D.; Yarin, V. I. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 5, 680-5(Sep-Oct 1971).

Translated from Kosm. Issled.; 9: No. 5, 741-7(Sep-Oct 1971).

A mass spectrometer on board the "vertical space probe" (VSP) measured the vertical distributions of the absolute densities of H^+, He^+, He^{++}, N^+, $^{16}O^+$, $^{18}O^+$, N_2^+, NO^+, and O_2^+ ions in middle latitudes at 1715 LT. The measurements showed that the main component of the atmosphere up to a height of approximately 1200 km was O^+ ions. The He^+ ion density did not exceed the H^+ ion density at heights of 600 to 4360 km, where the ratio of their densities was 10 to 30%; He^{++} ions at a density of 2 to 13 cm^{-3} were found at heights of 600 to 3000 km. The ratio of the He^{++} density to the He^+ density was $(4-8) \cdot 10^{-3}$. This ratio, calculated theoretically, was 10^{-3}. The ion temperature obtained from the vertical distribution of ion density was 2000°K at a height of 1000 km. (auth)

34345 PREDAWN EFFECT IN THE F2 REGION OF THE IONOSPHERE AT A POINT IN CONTACT WITH THE MAGNETIC FIELD. Bukin, G. V.; Kozorovitskii, L. L.; Kolokolov, L. E.; Sobolenko, D. N. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 5, 728-9(Sep-Oct 1971).

Translated from Kosm. Issled.; 9: No. 5, 789-90(Sep-Oct 1971).

Ivanov, one of the authors (Kozorovitskii), et al. found earlier in an experimental study of the propagation of heat in a plasma that, on local heating of electrons, the thermal perturbation may be propagated in the form of a wave whose front exhibits a spatial length that is substantially smaller than the mean free path of the hot particle. The velocity of the thermal front approaches the thermal velocity of the electrons and is always greater than the velocity of the ion sound calculated from the temperature of the hot electrons. The essence of the phenomenon is further elaborated here. It is shown that the energy flux transmitted along the force tube from the daylight side to the dark side can be determined, assuming that the dimensions of the heating region are approximately equal to the height of the F2 layer. At those altitudes of the F2 layer in which the concentration of the cold electrons is great, the generated photoelectrons move freely. The reason for the heating of the cold plasma electrons can be found in the ion-sound fluctuations generated by streams of cold and hot electrons. (J.C.W.)

34346 PROFILES OF ELECTRON DENSITY AND ELECTRON TEMPERATURE IN THE HEIGHT RANGE 80 TO 170 km. Komrakov, G. P.; Khryukin, V. G.; Chasovitin, Yu. K. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 5, 730-2(Sep-Oct 1971).

Translated from Kosm. Issled.; 9: No. 5, 791-3(Sep-Oct 1971).

Profiles of electron density and temperature were obtained in the height range 80 to 170 km from data collected on the MR-12 rocket July 10, 1969. The existence of the sporadic E layer was examined and correlations with other parameters were surveyed. The profile of the electron density shows that the values of N_e recorded in the D region are somewhat less than the values usually observed in summer in daytime at these heights. A clearly defined E layer was observed at heights of 100 to 114 km, its maximum electron density being $1.3 \cdot 10^5$ cm^{-3}. At 109 km, a narrow sporadic E was recorded, whose electron density exceeds that of the E region by a factor of 2.5. The profile of the electron temperature shows the individual values of T_e were averaged over a 5- to 10-km height range. Up to 155 km, the electron temperature increased fairly uniformly, and then increased rapidly up to 2600 K at a height of 170 km. (J.C.W.)

34347 STUDIES OF IONOSPHERIC INHOMOGENEITIES USING PHASE INTERFEROMETRY OF SATELLITE BEACON TRANSMISSIONS AT 136.410 MHz. Hajkowicz, L. A. (Univ. of Western Ont., London). Can. J. Phys.; 50: No. 4, 336-44 (15 Feb 1972).

A newly developed sensitive phase interferometer, based on a north–south and east–west antenna system, situated at London, Ontario, was used to record fast angle-of-arrival variations of the satellites ISIS-1 and ISIS-2 beacon transmissions at 136.410 MHz. The relative phase and corresponding amplitude scintillations indicate the presence of two distinct types of ionospheric irregularities, which were classified as A type and B type. A type events predominantly occurred in a time interval centered on local midnight, and the major disturbance areas were south of the station. A number of them showed a near-field effect, which indicated the presence of F-region field-aligned irregularities with large axial ratios. The B-type events, associated with the sporadic-E region, occurred at high elevation angles northwest and northeast of the station. Tentative results indicate that these events, predominantly recorded during daytime, are due to ionospheric irregularities occurring at altitudes considerably higher than those of the sporadic E region. (auth)

34348 SPECTRUM OF THE AIRGLOW BETWEEN 3 AND 4 MICRONS. Bunn, F. E.; Gush, H. P. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 50: No. 3, 213-25(1 Feb 1972).

The spectrum of the airglow in the region of 3 to 4 microns wavelength was measured through morning and evening twilight. A sudden drop in intensity of the $\Delta\nu = 1$ sequence of OH bands occurs at sunrise, with a slow recovery taking place during the day. A relatively smaller change occurs at evening twilight. (auth)

34349 STREAMS OF GEOMAGNETICALLY CAPTURED PROTONS WITH ENERGIES IN EXCESS OF 350 MeV, GENERATED BY ATMOSPHERIC LOSSES AND LOSSES RESULTING FROM NONADIABATICITY. Beloshitskii, V. V.; Il'in, V. D. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 5, 725-7(Sep-Oct 1971).

Translated from Kosm. Issled.; 9: No. 5, 787-9(Sep-Oct 1971).

Calculations were given for a stream of geomagnetically captured protons generated by a loss mechanism in the assumption that they are generated either entirely by atmospheric losses or by nonadiabatic losses. The disruption of the first adiabatic invariant may prove to be the fundamental reason for losses in high-energy protons, depending on the parameters L and B. The calculations, considering only the losses due to the atmosphere, are in agreement with observed intensities, correct to the order of magnitude, for $L < 1.5$ to 1.6. When $L \gtrsim 1.6$, the nonadiabatic losses exceed the atmospheric losses; in this case, the intensities resulting from the nonadiabatic effects are in good agreement with the measured effects when $J \gtrsim 10$ proton/$cm^2 \cdot$ sec. (J.C.W.)

34350 ELECTRON-TEMPERATURE ASYMMETRY AND THE STRUCTURE OF THE SOLAR WIND. Schulz, Michael (Aerospace Corp., El Segundo, Calif.); Eviatar, Aharon. Cosmic Electrodyn.; 2: No. 4, 402-22(Jan 1972).

The observational fact that, in the frame of the solar wind, outgoing thermal electrons have a somewhat larger mean energy than those incoming corresponds to an outward "heat flow" that can be simulated in the extreme by a purely exospheric model. Micro-instabilities of the interplanetary plasma are studied within the framework of an underlying electron–proton solar exosphere. Although collisions are neglected by definition, heat-flow moments of the distribution functions are significantly bounded by virtue of geometry. This fact permits velocity-space instabilities driven by heat flow to be analyzed under the most extreme conditions (exospheric) conceivably attainable. It is found that high-beta conditions typical of the solar wind at heliocentric distances ~1 AU substantially influence both wave-mode character (electrostatic vs electromagnetic) and instability thresholds for a variety of possible excitations (e.g., magnetosonic, whistler-mode, electromagnetic ion-cyclotron, electrostatic ion-cyclotron, ion-acoustic). Consequently, the character of interplanetary plasma turbulence, especially at long wavelengths, is substantially mixed and perhaps not attributable to a unique wave mode. Turbulence consequent to the various instabilities (that do not rely upon spatial inhomogeneity transverse to the flow direction) can influence temperature anisotropies and magnitudes, thermal transport along and across the magnetic field, and noncollisional coupling among various ionic solar-wind constituents (tending to equalize their bulk velocities). Moreover, velocity-space instabilities of the branch that corresponds to magnetosonic and whistler-mode waves appear capable of accounting in part for the observed structure of magnetic turbulence in the free-flowing solar wind. (auth)

34351 MICROPULSATIONS FROM A FINITE SOURCE. Greifinger, Phyllis (R and D Associates, Santa Monica, Calif.). J. Geophys. Res.; 77: No. 13, 2392-6(1 May 1972).

The polarization and the spatial and frequency dependence of the magnetic field at the ground resulting from a specified Pc1 disturbance of finite extent are obtained. At small lateral distances from the center of the incoming disturbance, the ground signal can be identified as a directly transmitted signal having the spatial properties of the incoming disturbance. The polarization and frequency characteristics of the direct signal are related to the corresponding properties of the incoming wave. At lateral distances that are large when compared to the size of the incoming disturbance, the signal can be identified as a ducted signal with properties that can be quite different. (auth)

34352 MAGNETIC APEX COORDINATES: A MAGNETIC COORDINATE SYSTEM FOR THE IONOSPHERIC F2 LAYER. Van Zandt, T. E.; Clark, W. L.; Warnock, J. M. (National Oceanic and Atmospheric Administration, Boulder, Colo.). J. Geophys. Res.; 77: No. 13, 2406-11(1 May 1972).

A magnetic coordinate system was developed to organize F2-layer data obtained from a range of heights in low and middle latitudes. Maps and tables of the apex coordinates are available at heights 0, 100, and 300 km and from 500 to 3500 km in steps of 500 above the Earth. McIlwain's L coordinate system and Mayaud's coordinate system are unsuitable for organizing F2-layer data in low and middle latitudes. The three coordinates of a point are its apex radius or apex latitude, which specifies a particular apex shell, its apex longitude, which specifies a particular field line in the shell, and its height above the Earth, which specifies two points on the magnetic-field line in the northern and southern hemispheres. (J.C.W.)

34353 CONVECTION ELECTRIC FIELDS AND POLAR THERMOSPHERIC WINDS. Fedder, Joel A.; Banks, Peter M. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 77: No. 13, 2328-40(1 May 1972).

From qualitative ideas of convection electric fields over the Earth's polar regions, the importance of ion drag in establishing a thermospheric wind system is demonstrated. Recent measurements indicate that uniform electric fields of 10 to 40 mv/m are a regular feature of the polar-cap ionosphere. Calculations of the neutral thermospheric wind, using these measured fields in a simple ionospheric model, have been made. The time scale for motion of the neutral gas ranges from less than 1 hour at F-region heights to about 2 hours in the dynamo region of the ionosphere. It has been found that the viscosity of the atmosphere is important in determining the winds in the dynamo region. Results are given that show ion-temperature enhancements of hundreds of degrees that are due to ion—neutral frictional effects. In addition, the total deposition rate of convection energy in the polar thermosphere is shown to be of the same order of magnitude as that due to absorption of solar euv radiation. The implications of these results for the dynamics and energetics of the thermosphere are discussed. (auth)

34354 MEASUREMENTS OF HORIZONTAL DRIFTS IN THE E AND F REGIONS AT MILLSTONE HILL. Evans, J. V. (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res.; 77: No. 13, 2341-52(1 May 1972).

At Millstone Hill (42.6°N, 71.5°W) an oblique-incidence incoherent-scatter radar system has been employed to observe the drift of the ionospheric plasma in the E and F regions in directions across the Earth's magnetic field. These measurements yield the true macroscopic motion of the ions rather than the motion of waves impressed in the plasma, but, owing to sensitivity limitations, measurements could be made only during the daytime when the electron density is large. It is found that the drift appears to be independent of altitude above about 180 km; this result suggests that the drift is caused by an electrostatic field. On the average the drift has an amplitude of about 25 m/sec (1 mV/m), and the direction rotates in a clockwise sense through 360° in 12 hours. The drifts observed at 130 km appear similar to the drifts in the F region, but in azimuth the direction lags behind the drift observed in the F region by 50 to 60°. It appears that the electric field responsible for the drift in the F region is generated in the E region by the dynamo action of the solar semidiurnal (2,2) tidal oscillation. On one day electric fields of magnetospheric origin developed following a magnetic storm's sudden commencement. The clockwise progression of the drift was then reversed, and the drift reached 200 m/sec toward the west. This motion may be connected with the reported sunward surges of the plasma in the plasmasphere bulge at times of substorms. (auth)

34355 DIFFUSION MODEL FOR THE PHASE DELAY BETWEEN THERMOSPHERIC DENSITY AND TEMPERATURE. Mayr, H. G. (Goddard Space Flight Center, Greenbelt, Md.); Volland, H. J. Geophys. Res.; 77: No. 13, 2359-67(1 May 1972).

Considering a two-dimensional time-dependent model in which the thermosphere dynamics is excited by the uv heat input within the thermosphere, it is shown that the wind-induced variations in the diurnal component of atomic oxygen dominate over its temperature-induced variations up to 200 km. The assumption of diffusive equilibrium is therefore in general not valid for O within the lower thermosphere. The effect of the diurnal wind circulation is to redistribute O so that (a) the diurnal variations in the $[O]/[N_2]$ and $[O]/[O_2]$ ratios are damped by about 20%, thus contributing to the maintenance of the nighttime F2 region, and (b) the maximum in the diurnal variation of O is shifted by one to two hours away from the temperature maximum toward noon, thus contributing significantly to the temperature-density time lag at thermospheric heights above 200 km, where O becomes the major constituent. (auth)

34356 LATITUDINAL DIURNAL VARIATION OF SOME ATMOSPHERIC PARAMETERS DETERMINED BY A SIMULTANEOUS ANALYSIS OF INCOHERENT-SCATTER AND SATELLITE-DRAG DATA. Alcayde, D. (CNRS, Toulouse); Bauer, P.; Jaeck, C.; Falin, J. L. J. Geophys. Res.; 77: No. 13, 2368-76(1 May 1972).

Oxygen concentrations obtained from satellite-drag and incoherent-scatter observations over the period of February 6—10, 1969, are presented for comparison. A good agreement is shown to exist between both types of data, which are also compatible with the Jacchia (1970) model. This model is found to be in closer agreement with the incoherent-scatter data than the Jacchia (1965) model, for the oxygen concentrations as well as for the exospheric temperatures. However, indications of a somewhat different diurnal variation of the observed densities with respect to the model are present. These features can be interpreted as being due to combined changes of the exospheric temperature, the shape of the temperature profile, and the boundary conditions at low altitude. In particular, they suggest that the oxygen concentration in the lower thermosphere undergoes both diurnal and semidiurnal oscillations. (auth)

34357 IONOSPHERIC PROPAGATION OF OBLIQUE HYDROMAGNETIC PLANE WAVES AT MICROPULSATION FREQUENCIES. Greifinger, Phyllis (R and D Associates, Santa Monica, Calif.). J. Geophys. Res.; 77: No. 13, 2377-91(1 May 1972).

The high-latitude transmission and reflection properties of the ionosphere for oblique hydromagnetic plane waves in the Pc1 frequency regime are considered. Transmission and reflection coefficients for the upper and lower ionosphere are obtained for daytime and nighttime conditions. The results are compared with those obtained for a vertically incident plane wave. (auth)

34358 ABSORPTION IN THE D AND E REGIONS AT 2.2 MEGAHERTZ. Purkait, N. N.; Datta, S. K. (Univ. of Calcutta). J. Geophys. Res.; 77: No. 13, 2397-2400(1 May 1972).

Absorption at 2.2 MHz caused by the D and E regions of the ionosphere over Haringhata (22°54'N, 88°34'E) has been studied. The data suggest that the D region over Haringhata is mainly solar controlled. The average value of the cos χ index of D-region absorption is found to be 1.35. The results are compared with those obtained from other sources. (auth)

34359 SATELLITE OBSERVATIONS OF WHISTLER-MODE SIGNALS IN THE CONJUGATE REGION OF A 200-KILOHERTZ STATION. Laaspere, Thomas; Orphanoudakis, S. C. (Dartmouth Coll., Hanover, N. H.). J. Geophys. Res.; 77: No. 13, 2319-27(1 May 1972).

The payload of polar-orbiting Ogo 6 included a narrow-band ($\simeq$ 200 Hz) receiver at 200 kHz connected to an electric dipole antenna. The signals recorded by this receiver at the station and in the conjugate region of Achkhabad (58°23'E, 37°57'N) were studied. The latitude of this station is nearly low enough ($\simeq$ 30.5° invariant latitude) for propagation of a 200-kHz signal in the ducted whistler mode to the conjugate hemisphere along field lines terminating at the station. In the dawn-dusk orbital plane signals are indeed relatively often observed in the conjugate region, but the source of the signals and their path of propagation is not completely clear. The pattern of observations is consistent with propagation over the long magnetospheric path in field-aligned ducts spread in longitude near 22° invariant latitude, but an interpretation is favored involving nonducted propagation in which the occasionally high electric-field intensities encountered (>10 μv/m) result from focusing effects or from propagation near the resonance angle. (auth)

34360 MIDDAY AURORAS AT THE SOUTH POLE DURING MAGNETOSPHERIC SUBSTORMS. Akasofu, S.-I. (Univ. of Alaska, College). J. Geophys. Res.; 77: No. 13, 2303-8(1 May 1972).

It is shown that there is a close relationship between the range of the equatorward shift of the midday aurora and the magnitude of a negative bay at an auroral-zone station in the midnight sector. Their time variations are also similar. This relationship can be taken to be a clear indication of a close association of magnetospheric substorms with the transfer of the magnetic flux from the front of the magnetosphere to the magnetotail. Furthermore, the intensity of magnetospheric substorms appears to be approximately proportional to the net amount of transferred magnetic flux. (auth)

Effects of Nuclear Detonations

34361 (NDRE--57) ELECTRIC AND MAGNETIC FIELDS PRODUCED IN LOW-ALTITUDE NUCLEAR EXPLOSIONS. Thoresen, P. (Forsvarets Forskningsinstitutt, Kjeller (Norway)). Mar 1970. 103p. INIS.

The close-in electric and magnetic fields produced by the gamma-ray-induced currents from a nuclear explosion are evaluated. Maxwell's equations are solved using an analytically described source function. The source function evaluated takes into account the prompt gamma-ray emission from the fission products and from the neutron reactions. Atmospheric parameters of importance for the calculations of the air conductivity are discussed, and numerical results of the computed air conductivity are shown. The electric and the magnetic fields are computed using a developed analytical function for the Compton current based on the gamma-ray source function. Some numerical results illustrate the time and space variation of the electric and magnetic fields. (auth)

34362 THEORY OF THE EXCITATION AND PROPAGATION OF LAMB'S ATMOSPHERIC EDGE MODE FROM NUCLEAR EXPLOSIONS. Pierce, Allan D.; Posey, Joe W. (Massachusetts Inst. of Tech., Cambridge). Geophys. J. Roy. Astron. Soc.; 26: No. 1-4, 341-68(Dec 1971).

A relatively simple theoretical model of near-surface pressure pulse propagation from nuclear explosions is developed from the hypothesis that the early portion of the pulse travels in the real atmosphere's counterpart of Lamb's edge mode. Various concepts of geometrical acoustics are used in the construction of the model. The pulse travels along horizontal ray paths that may be refracted by horizontal variations in the height-averaged effective sound, speed and wind velocity. The dispersion of the pulse as it propagates along such paths is governed by a one-dimensional wave equation similar to that derived by Korteweg and de Vries (1895). Coefficients are found by comparison with the dispersion relation derived by Garrett (1969) as an expansion in terms of a parameter ϵ describing deviations of the atmospheric profile from isothermal. The method of incorporation of terms governing accumulative far-field nonlinear effects is indicated. Height variations in propagating variables are approximated to zeroth order in ϵ. Variations along horizontal ray paths are governed by the principle of conservation of modal wave action. The excitation of the edge mode is found by matching the general form of the far-field quasi-geometrical solution to the near-field solution for a point energy source in an isothermal atmosphere. Explicit expressions are given for the far-field pressure disturbance. Computations agree favorably with those based on a multimode theory for the first few cycles of the waveform. The edge mode theory leads to a number of implications, which may be compared with existing data. These include the prediction that the energy of the explosion yield may be estimated from a knowledge of the first peak-to-peak period and first peak-to-trough pressure amplitude in far-field records with very little information concerning atmospheric structure, and the predictions that anomalous azimuthal variations in waveform amplitudes may be caused by focusing or defocusing of horizontal ray paths for the edge mode. (auth)

34363 SECOND-ORDER CORRECTION TO THE REED--OTTERMAN THEORY. Kahalas, S. L.; Murphy, B. L. (Mount Auburn Research Associates Inc., Newton, Mass.). Geophys. J. Roy. Astron. Soc.; 26: No. 1-4. 379-89(Dec 1971).

The theory of Reed and Otterman, which describes the propagation of a weak shock wave in an inhomogeneous medium, is extended to include the next higher-order term of relative overpressure. This extension allows a matching of theory to initial starting conditions of the shock at a point closer to the source than the Reed--Otterman theory itself. The modified theory gives a value of the shock pressure that agrees well with the numerical calculation performed by Greene and Whitaker for the upward moving shock wave from a low-altitude detonation. (auth)

34364 ACOUSTIC-GRAVITY WAVE GENERATION AT 120 km ALTITUDE BY SEA LEVEL DETONATION: A PRELIMINARY ANALYSIS OF THE GREENE-WHITAKER CALCULATION. Kahalas, S. L.; Murphy, B. L. (Mount Auburn Research Associates, Inc., Newton, Mass.). Geophys. J. Roy. Astron. Soc.; 26: No. 1-4, 391-8(Dec 1971).

The Greene and Whitaker mechanism for the production of an acoustic-gravity wave in the 100-km region of the ionosphere is discussed from a physical point of view. The shock wave from a low-altitude detonation propagates upward and, interacting with the atmosphere in the 100 km region, produces a horizontally propagating acoustic-gravity wave. Several aspects of this phenomenon are discussed. The initial period of the generated waves is in the range 200 to 300 s, the energy associated with the wave is about 0.3% of the yield, and the wave generated appears to result principally from the refraction of the shock at the 100-km level. (auth)

34365 DISTANT SEISMIC WAVES FROM A HIGH-ALTITUDE SOURCE. Nickel, George H.; Whitaker, William A. (Air Force Weapons Lab., Kirtland AFB, N. Mex.). Geophys. J. Roy. Astron. Soc.; 26: No. 1-4, 369-78(Dec 1971).

Calculations are presented for the description of seismic waves created by the reflection of a spherical shock wave from the surface of the Earth. The Earth is represented by a homogeneous medium, but in order to reproduce measured dispersion data the elastic constants are allowed to vary with the frequency of each Fourier component of the incident pulse. The shock is represented by three parameters; a radius of curvature h, a maximum overpressure p_0, and a duration of positive overpressure t_+. The amplitude of a Rayleigh wave whose period is much less than $2\pi t_+$ is proportional to p_0 h. (auth)

Particle Kinetics and Trapping

Refer also to abstracts 34259 and 34334.

34366 (UCRL--51185) OSO-4 ELECTRON OBSERVATIONS IN THE EDGE OF THE INNER RADIATION ZONE. Knox, Richard J. (California Univ., Livermore. Lawrence Livermore Lab.). 23 Feb 1972. Contract W-7405-eng-48. 80p. Dep. NTIS.

Unidirectional electron flux intensities and differential energy spectra for $1.25 \leq L \leq 1.9$ measured in March 1968 using a directional electron spectrometer on the OSO-4 spacecraft are reported. Unidirectional differential intensities normal to the field line ($j_\perp$) are given for $E_e \geq 80.5$ keV and for eight energy ranges to 5.33 MeV. Integral pitch-angle distributions are presented. Pitch-angle plots are also shown for November 1967 data. Favorable comparisons were made with LLL's OGO-5 electron energy-spectra (March 1968), particularly at energies less than 1.0 MeV. Although the instrument was also designed to measure protons (1.73 to 65 MeV), the proton data were made invalid due to penetrating high-energy protons. Data were accumulated along the edge of the inner belt for $1.1 \leq L \leq 2.2$ within a narrow band of λ values that approached within a few degrees of the magnetic equator at the lower L values and increased to about 45° at the higher L values. It appears that the more complete analysis of OSO-4 electron data can, in part, fill a gap in the time history of inner-zone electron events during the 1967--1968 time period. (auth)

34367 OBSERVATION OF ENERGETIC PARTICLES AT VERY LOW ALTITUDES NEAR THE GEOMAGNETIC EQUATOR. Hovestadt, D.; Haeusler, B.; Scholer, M. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Phys. Rev. Lett.; 28: No. 20, 1340-4(15 May 1972).

A considerable flux on the order of 7 particles/cm^2 sec sr (probably protons) in the energy range above 500 keV is observed in the vicinity of the magnetic equator. The particles show a narrow distribution around 90° pitch angle. The low minimum altitudes of the drift paths of the particles in the L region between 1.0 and 1.15 prevent a full drift around Earth. The particles are probably injected at several hundred kilometers altitude by a yet unknown mechanism. (auth)

34368 MAGNETIC EFFECTS DUE TO THE NEUTRAL SHEET. Huang, Yao-hui. Lawrence, Kan.; Univ. of Kansas (1971). 147p. University Microfilms Order No. 72-11,755. Thesis.

The magnetic field in the Earth's magnetotail is calculated from assumed divergenceless electrical currents in the magnetic equatorial plane and on the tail surface. The assumed currents are an equatorial current sheet across the diameter of the magnetotail with a cross section varying from one Earth radius in the meridian plane to eight Earth radii at the outer edge of the tail, plus a thin sheet of return current on the upper and lower edge of the tail of magnitude one-half that of the total equatorial current. The current decreases with distance from the earth X as $1/|x|^{1/3}$. The results for the calculated field match well the few experimental observations of the field where measurements have been made and give values of the magnetic-field intensity and direction in regions unobserved by satellite magnetometers. The drift motion of particles due to the gradient of the magnetic field is calculated. This partial current corresponds to the initial assumed current and matches the equatorial current inferred from satellite observations by Speiser and Ness. (Diss. Abstr. Int., B)

34369 ACCOUNT OF THE FINITE CONDUCTIVITY OF THE MAGNETOSPHERIC PLASMA. Barsukov, V. M. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 565-7(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 617-20(Jul-Aug 1971).

First satellite observations showed that the force lines on the night side of the magnetosphere near the equatorial plane are extremely stretched out away from the Sun, starting at a distance of 7 to 10 R_E. Experiments showed that the vertical component of the magnetic field in the plane of the ecliptic vanishes. It was concluded that the force lines are broken in this region, because of the presence of a perfectly conducting plasma (the neutral layer). Recent satellite observations show that the force lines, while highly stretched out, close through the neutral layer. The plasma of the neutral layer must have a finite conductivity. Theories that have been presented are that this layer is formed by a plasma of the solar wind that flows into the magnetosphere across its boundaries at 7 to 10 R_E from the Earth near the equatorial plane and it may be concluded that the entire plasma layer, occupying a region much larger than that of the neutral layer discovered earlier, is formed by this mechanism. The finite conductivity is discussed, treating the plasma in the plasma layer as having a finite conductivity and as moving away from the Earth at the solar-wind velocity. As it moves, such a plasma may stretch the force lines away from the Sun. (J.C.W.)

34370 EFFECT OF PLASMA SHEET ON THE CHARACTERISTIC OSCILLATIONS OF THE MAGNETOSPHERIC TAIL. Nusinov, A. A. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 4, 562-4(Jul-Aug 1971).

Translated from Kosm. Issled.; 9: No. 4, 615-17(Jul-Aug 1971).

A model of the tail in the form of an infinite plasma cylinder embedded in the interplanetary plasma is considered to study the effect of the plasma sheet on the nature of the characteristic oscillations. The presence of the plasma sheet can be approximately taken into consideration by assuming that inside the tail there is a coaxial plasma cylinder, for which the plasma density, the magnetic field, and the transverse cross section coincide with the corresponding parameters of the plasma sheet. A mathematical analysis is given. (J.C.W.)

34371 AMPLITUDE VARIATIONS IN ARTIFICIALLY STIMULATED VLF EMISSIONS. Diesendorf, M. O. (Imperial Coll. of Science and Tech., London). Nature (London) Phys. Sci.; 236: No. 65, 56-8(27 Mar 1972).

The observation is reported of large regular and irregular classes of amplitude fluctuation within artificially stimulated vlf emissions triggered by long low-power pulses (10.2 kHz) from ground transmitters of the Omega network, received on the ground in the magnetically conjugate zone of the transmitter after following a magnetospheric trajectory. The pulses were transmitted from Forest Port, N. Y., received, and recorded by Stanford University on May 9, 1963. Examples are depicted photographically, discussed, and observations are compared with those of other studies. (UK)

34372 EFFECTS ON THE PLASMASPHERE OF A TIME-VARYING CONVECTION ELECTRIC FIELD. Chen, A. J.; Wolf, R. A. (Rice Univ., Houston, Tex.). Planet. Space Sci.; 20: No. 4, 483-509(Apr 1972).

The time evolution of the plasmasphere is investigated theoretically, using simple computational models. The magnetic field is assumed to be dipolar and time-independent, but the convection electric field is allowed to vary in time. For purposes of comparison, various spatial distributions of the magnetospheric electric field are considered. Plasmasphere flux tubes are assumed to be filled by diffusion of plasma upwards from the dayside ionosphere. Following a reduction in the convection field, the bulge of the original plasmasphere develops into a long tail that gradually wraps itself around the main plasmasphere. Periodic gusts in a spatially uniform convection field produce extremely complicated fine structure that depends strongly on both local time and universal time. Each large gust produces a distinct tail of cold plasma that stretches from the main body of the plasmasphere to the magnetopause, and causes a peak in density, outside the main plasmapause; similar features have been observed by OGO satellites. The calculations indicate that a periodic gusty field has a major effect on the size of the plasmasphere if the field has large Fourier components close to the drift period of cold plasma near the plasmapause. Gusts occurring randomly, at an average rate of several a day, can also cause substantial reduction in the size of the plasmasphere. The assumption that the convection field is spatially uniform, but gusty, leads to better agreement with the observed average shape of the plasmasphere than the assumption of a constant, uniform electric field. The theory indicates that the thickness of the plasmasphere boundary should be inversely correlated with magnetic activity, in general agreement with OGO-5 observations. (auth)

34373 NONLINEAR MODULATION OF A QUASI-MONOCHROMATIC PACKET OF WHISTLERS IN THE MAGNETOSPHERE. Istomin, Ya. N.; Karpman, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 4, 143-6(20 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 4, 208-11(20 Feb 1972).

An experiment is described in which ratio waves were emitted by a land-based transmitter and registered by a receiver located at the magnetically conjugate point. It is recognized that the state of the plasma in the equatorial region of the magnetosphere is very frequently characterized by an anisotropic distribution function; therefore, the whistlers passing through it can be amplified to such an extent that nonlinear effects become significant. Some nonlinear effects due to the bounded nature of the wave packet are considered, but previously, wave packets with sharp boundaries were considered. A rectangular wave packet entering into the active region of the magnetosphere is considered, and all the parameters involving the amplitude and frequency modulation are examined. (J.C.W.)

34374 DEVELOPMENT OF A CURRENT LAYER WHEN PLASMA MOVES IN A MAGNETIC FIELD WITH A NEUTRAL LINE. Syrovatskii, S. I.; Frank, A. G.; Khodzhaev, A. Z. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 3, 94-8(5 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 3, 138-42(5 Feb 1972).

An experiment is described in which a current layer was successfully produced in which the magnetic-field gradient was much larger than the gradient of the initial field. The case of two-dimensional motion of a plasma in the vicinity of a neutral line of a magnetic field was investigated with a quasi-stationary magnetic field of quadrupole configuration. The neutral line of the magnetic field was aligned with the axis of a cylindrical glass vacuum chamber. An induction Θ discharge was excited in the quadrupole field to produce a plasma. After filling the chamber with plasma, the inducing electric field was turned on, and the direction of this field coincided with the neutral line of the quadrupole magnetic field and with the axis of the vacuum chamber. The electric field caused the plasma to move and produced a current in it, and distorted the initial quadrupole magnetic field. Two components of the magnetic field were measured in the (x,y) plane. Results show that an electric field directed along a neutral line of the magnetic field gives rise to a current layer that separates oppositely directed magnetic fields. The developing current layer distorts the initial magnetic field and produces an excess of magnetic energy in the vicinity of the neutral line. (J.C.W.)

34375 PROJECTION OF THE MIDDAY MAGNETOSPHERIC BOUNDARY UNDER CONDITIONS OF DIVERSE GEOMAGNETIC DIPOLE ORIENTATION. Antonova, A. E.; Eroshenko, E. G.; Fel'dshtein, Ya. I. Cosmic Res. (USSR) (Engl. Transl.); 9: No. 5, 723-4(Sep-Oct 1971).

Translated from Kosm. Issled.; 9: No. 5, 786-7(Sep-Oct 1971).

Simulation studies have shown that the latitude Φ' near the midday boundary of the magnetosphere, projected along the force line onto the surface of the Earth, depends strongly on the orientation of the geomagnetic dipole axes with respect to the plane of the ecliptic (angle δ). The values of the δ were determined from the observational results obtained on the crossing of the magnetospheric boundary by the IMP satellites and the model studies. The value of Φ' for corresponding δ at the instants at which the satellite crosses the magnetospheric boundary was found from the model with an accuracy of up to 0.5°. The position of the magnetospheric boundary was plotted on the model force lines derived for δ closest to that calculated for the instant of intersection. Two variants possible are (1) the boundary of the magnetosphere was observed within the limits of the model boundary, and (2) the boundary of the magnetosphere was situated beyond the boundaries of the model. (J.C.W.)

34376 INTRUSION OF FAST PARTICLES INTO THE MAGNETOSPHERE (MODEL EXPERIMENTS). Podgorny, I. M.;

Dubinin, E. M. (Inst. for Space Research, Moscow). Cosmic Electrodyn.; 2: No. 4, 453-9(Jan 1972).

Precipitation of fast particles in the magnetosphere was investigated using simulation experiments. The model magnetosphere was created by a plasma stream interaction with a dipole magnetic field. The parameters of the experiment were chosen using the principle of limited simulation. It is shown that the region of the fast particle (W ~ 6 keV) penetration on the day side exceeds that estimated from nonconservation of the adiabatic invariants. After penetration into the cusp, electrons drift around the magnetic pole. The dimension of the penetration cross section may be determined by the border instability or diffusion through the front surface and, after that, drift along the field lines. The penetration of fast particles was found on the night side in the region that separates the magnetotail lines and lines of the closed magnetosphere. (This article also appears in Russian immediately preceding, pp. 445-452.) (auth)

34377 GEOMAGNETIC TAIL OSCILLATIONS. Ershkovich, A. I.; Nusinov, A. A. (Inst. for Space Research, Moscow). Cosmic Electrodyn.; 2: No. 4, 471-80(Jan 1972).

A model of the Earth's magnetic tail is considered as a plasma cylinder (with a free boundary-tangential discontinuity surface), immersed into the solar-wind plasma. A dispersion equation describing oscillations is obtained. Oscillation amplitudes excited due to variations in solar-wind velocity are estimated. The Kelvin–Helmholtz instability (arising when the solar-wind velocity is high enough) is investigated. The plasma sheet influence on tail oscillations is taken into account. It is shown that a number of quasi-periodic events in the magnetosphere (with periods of some tens up to some hundreds of minutes) display magnetotail oscillations excited from solar-wind parameter variations. (This article also appears in Russian immediately preceding, pp 460-70.) (auth)

34378 STRUCTURE OF THE GEOMAGNETIC TAIL AND SUBSTORM ACTIVITY. Hruska, A. (National Center for Atmospheric Research, Boulder, Colo.). Cosmic Electrodyn.; 2: No. 4, 481-90(Jan 1972).

The analysis of the IMP-3 magnetic data shows that the rate of change of the magnetic field in the solar direction $\partial B/\partial X$ (X, Y, Z are solar magnetospheric coordinates) varies with position in the tail. The thickness of the plasma sheet changes with substorm activity and the magnetic-field strength decreases from the tail towards its flanks. The correlation between time derivatives of the magnetic field and time variation of the AE index is discussed. The tail structure probably reaches a "limiting configuration" (configuration which does not further change with time) within about 2 or 3 hr after extremum of AE-index, unless another extremum of AE occurs earlier. Maxima of substorm activity are very often preceded by a decrease of magnetic field in the plasma sheet. (auth)

34379 PARTICLE-FLUX LIMITS IN THE SYNCHRONOUS ORBIT. Mozer, F. S. (Univ. of California, Berkeley). J. Geophys. Res.; 77: No. 13, 2401-3(1 May 1972).

Proton and electron fluxes measured in synchronous orbit on the ATS-5 satellite were measured for evidence of the stably trapped flux limits, to determine these limits, and to study the local time dependences of their existence. Data used are the 40- and 75-keV differential electron fluxes and the 60- and 120-keV differential proton fluxes measured by the detector. It is shown that fluxes of the particles often approach but rarely exceed limiting values that agree within a factor of about 2 with the fluxes predicted by Kennel and Petchek (1966) from consideration of whistler-mode wave–particle interactions. Local-time dependences of the probabilities that the proton and electron fluxes are within a factor of 2 of their trapping limits are shown graphically. Other phenomena related to the study are discussed. (J.C.W.)

34380 DIFFERENTIAL ENERGY SPECTRUM OF GEOMAGNETICALLY TRAPPED PROTONS WITH THE ESRO 2 SATELLITE. Valot, P. (CEN de Saclay, Gif-Sur-Yvette, France). J. Geophys. Res.; 77: No. 13, 2309-18(1 May 1972).

The proton energy spectrum in the inner Van Allen zone was investigated in the range 30 to 300 MeV with a solid state dE/dx telescope aboard the ESRO-2 satellite. The B-L domain covered is $1.3 \leq L \leq 2.4$ and $0.18 \leq B \leq 0.24$. It was found that an exponential spectrum $f\,[E] = N_0 \exp(-E/E_0)$ is a good fit to the data in the range L = 2 to L = 2.4. For L < 2, a composite exponential spectrum is more suitable for describing the observed shape: Between 30 MeV and a "knee-energy" E_c, $f\,[E] = N_1 \exp(-E/E_1)$ and for $E > E_c$, $f\,[E] = N_0 \exp(-E/E_0)$. From our data, the variations with L of the parameters E_c, E_0, E_1 were found to be (a) $E_1 = (148 \pm 8)$ MeV; (b) $E_0 = (290 \pm 20)\,L^{-3.3\pm0.3}$; and (c) $E_c = (400 \pm 20)\,L^{-3\pm0.2}$. It is suggested that two injection mechanisms are operating for all of this energy range, and that they give rise to two populations. The first one is the main component at energies lower than 25 MeV. At energies higher than our threshold (30 MeV), the detected fluxes are the addition of a second population (main component) and the high-energy tail of the first population. The spectrum of this second population appears to have the characteristic shape of a spectrum altered by ionization losses and generated by a continuous source, the slope for energies greater than E_c being E_0. (auth)

Solar Wind and Cosmic Ray Interactions

Refer also to abstracts 34029, 34288, and 34350.

34381 SOLAR WIND EXPANSION BEYOND THE HELIOSPHERE. Bhatnagar, V. P.; Fahr, H. J. (Univ., Bonn). Planet. Space Sci.; 20: No. 4, 445-60(Apr 1972).

A model of solar-wind expansion beyond the heliosphere is given on the basis of the assumption of a continuous, stationary out-flow. The distributions of the hot solar-wind protons, and the constituents resulting from charge-exchange collisions of these protons with the cool interstellar atomic hydrogen, like hot neutral atomic hydrogen and cold protons, were investigated for the region beyond the heliosphere. The effect of the relative motion between cool interstellar atomic hydrogen and the solar-wind protons in the interstellar space is included. It is shown on the basis of the continuity of the mass, energy, and magnetic flux that the assumption of a steady-state solar-wind flowing continuously from the heliosphere into the interstellar space without strong shocks that cause instabilities and turbulences breaks down when the angle θ between radial flow of the solar-wind protons in the heliosphere and the direction of the interstellar magnetic field exceeds about 50 to 60 degrees. For angles smaller than 50°, the solar-wind plasma is able to flow through an infinite cylindrical channel, its axis coincides with the direction of the interstellar magnetic field. The radius of the cylinder is that of the heliosphere. The shocks at the heliopause are found to be non-symmetric around the Sun contrary to most recent ideas concerning the termination of the solar wind. (auth)

34382 PULSED INCREASE OF INTENSITY OF SOLAR X RAYS ON DECEMBER 10, 1970. Kocharov, G. E.; Charikov, Yu. E.; Kharchenko, A. A.; Gusev, G. V.; Baskakov, A. V. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 15: No. 3, 105-7(5 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 3, 153-6(5 Feb 1972).

The Dec 10, 1970 solar x-ray burst registered by the RIFMA spectrometric apparatus on the mobile automatic laboratory Lunokhod-1 is analyzed. The energy and time of arrival of each individual quantum were recorded so that the dynamics of solar x-ray generation could be studied. The energy range of the registered quanta was determined by the geometry and the operating system of the proportional counters, and the 15- to 30-keV energy range was studied. The temporal characteristics as determined from the time dependence of the x-ray quantum-detector counting rate are shown. It is known that three mechanisms of solar x-ray generation are being considered: quasithermal plasma radiation, nonthermal radiation with pulsed injection, and nonthermal with continuous injection of electrons into the region of x-ray generation. The results shown here favor the nonthermal mechanism with pulsed injection. (J.C.W.)

34383 EARTH'S BOW SHOCK IN AN OBLIQUE INTERPLANETARY FIELD. Shen, Wen-wu (Univ. of Kansas, Lawrence). Cosmic Electrodyn.; 2: No. 4, 381-95(Jan 1972).

The pressure, magnetic field, temperature, particle density, and stream velocity throughout the magnetosheath have been calculated in the plane containing the interplanetary field and solar wind velocity vector for various orientations of the interplanetary magnetic field and various assumed ratios of specific heats of the compressed solar wind. Jump conditions at the bow shock gave initial conditions in the shocked plasma from which the appropriate hydromagnetic equations (for blunt bodies in the subsonic region near the subsolar point and for the method of characteristics in the supersonic region back in the tail) were integrated numerically back to the surface of the magnetosphere. Explicit consideration of the magnetic field shows that a net asymmetrical force on the magnetopause produces a side force, or "lift" in addition to the well-known drag on the magnetosphere. (auth)

34384 HEATING OF THE SOLAR WIND IONS. D'Angelo, N. (European Space Research Inst., Frascati, Italy); Jensen, V. O. Cosmic Electrodyn.; 2: No. 4, 396-8(Jan 1972).

The suggestion is advanced that the high ion temperatures in the solar wind, observed near the Earth's orbit, may be associated with the presence of an influx of neutral hydrogen from the boundary of the heliosphere. Photoionization and charge exchange transform neutral hydrogen atoms into protons. The ionized hydrogen component near the Earth's orbit is then double-peaked and unstable. The kinetic energy of the protons (originating from the neutral hydrogen component) in the rest frame of the solar-wind ions, may then be sufficient to produce the observed ion heating. (auth)

34385 SOLAR CURRENT PENETRATION INTO THE MAGNETOSPHERE. Parthasarathy, R. (Univ. of Alaska, College). Cosmic Electrodyn.; 2: No. 4, 399-401(Jan 1972).

The plausibility and consequences of a current flow extending from the Sun and into the interplanetary medium is considered speculatively. It is argued that a major consequence is to engender a temporarily over-extended tail by inhibiting reconnection of field lines across the neutral sheet. Order-of-magnitude calculations are made of the several other observable perturbations in the magnetosphere. (auth)

34386 TESTING GEOMAGNETIC DATA BY INCLUDING A MONOPOLE TERM IN THE SPHERICAL HARMONIC REDUCTION. Vinti, John P. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res.; 77: No. 13, 2404-5(1 May 1972).

It is expected that the Earth has a small magnetic monopole moment and could be searched out by including a monopole term in the spherical harmonic expansion and solving for its coefficient in reducing the data. In the Gaussian units, from the explanation given, if r is the position vector of a field point relative to an origin inside the Earth, such a monopole term would appear as m/r in the expansion for the scalar magnetic potential or as mr/r^3 in the expansion for B. A supposition is discussed on the assumption that a net monopole volume density to have been present at Earth formation. New physical results are obtained from the supposition that the geomagnetic data that are to be reduced cover the whole Earth and have all been reduced to the same time, coming from terrestrial or satellite observations. (J.C.W.)

34387 MULTIFARIOUS TEMPORAL VARIATIONS OF LOW-ENERGY RELATIVISTIC COSMIC-RAY ELECTRONS. McDonald, F. B. (Goddard Space Flight Center, Greenbelt, Md.); Cline, T. L.; Simnett, G. M. J. Geophys. Res.; 77: No. 13, 2213-31 (1 May 1972).

A detailed examination is made of the intensity variations of 3- to 12-MeV interplanetary electrons. The data are from the Goddard cosmic-ray experiment on the Imp satellites and cover the period from just before the last solar minimum through the onset of the present solar maximum (i.e., from December 1963 through August 1969). A morphology for the intensity changes is tentatively proposed that includes solar-flare-associated events, solar corotating increases, Forbush decreases, quiet-time increases, and the long-term 11-year variation. It is contended that the electron components observed both during quiescent times and during quiet-time increases are galactic in origin. The quiet-time increases represent a completely new phenomenon that appears to be unique to the low-energy electron population. During a quiet-time increase the electron intensity is enhanced by a factor of 3 to 5 over a period of days, and, in general, these periods anticorrelate with low-energy solar particle events. Qualitatively, their amplitude diminishes with increasing solar activity. One possible explanation for the origin of quiet-time increases, which involves the augmented penetration of galactic electrons into the inner solar system, is suggested in the accompanying paper by Fisk and Van Hollebeke (1972). Because of the large short-term changes, the 11-year modulation of these low-energy galactic electrons is not well defined. An upper limit of a factor of 2.3 is placed on the intensity change observed from solar minimum to solar maximum. (37 references) (auth)

34388 QUIET-TIME ELECTRON INCREASES: A MEASURE OF CONDITIONS IN THE OUTER SOLAR SYSTEM. Fisk, L. A.; VanHollebeke, M. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 13, 2232-49(1 May 1972).

One possible explanation for the increases in the intensity range of 3- to 12-MeV interplanetary electrons that McDonald et al. (1972) have labeled as "quiet-time electron increases" is discussed. It is argued that the electrons in quiet-time increases are galactic in origin but that the observed increases are not the result of any variation in the modulation of these particles in the inner solar system. It is suggested instead that quiet-time increases may occur when more electrons than normal penetrate a modulating region that lies far beyond the orbit of the earth. The number of electrons penetrating this region may increase when field lines that have experienced an unusually large random walk in the photosphere are carried by the solar wind out to the region. As evidence of this increased random walk, it is shown that five solar rotations before most of the quiet-time increases occur there is an extended period when the amplitude of the diurnal anisotropy (measured by the Deep River neutron monitor) is relatively low. A delay time of five rotations implies that the proposed modulating region lies at ~30 AU from the Sun if the average solar-wind speed is assumed to be constant at ~400 km/sec over this distance. The implications for the correlation between periods of low-amplitude diurnal anisotropy and quiet-time increases on interplanetary conditions out to ~30 AU and some possible models for the proposed modulating region are also considered. (37 references) (auth)

34389 DISSIPATION MECHANISMS IN A PAIR OF SOLAR-WIND DISCONTINUITIES. Unti, T. W. J. (California Inst. of Tech., Pasadena); Atkinson, G.; Wu, C.-S.; Neugebauer, M. J. Geophys. Res.; 77: No. 13, 2250-63(1 May 1972).

A pair of sharp closely-spaced discontinuities in the solar wind was recorded by the high-time resolution instruments aboard Ogo 5 on March 14, 1968. There is plasma turbulence within the double structure, and there appear to be small-amplitude hydromagnetic waves radiating from the discontinuities. The generation of the plasma turbulence is discussed in terms of magnetic drift waves. Although it seems probable that the surfaces are tangential discontinuities, arguments are also advanced that the double structure may represent the Petschek mechanism in which rapid field-line merging occurs between standing waves. (auth)

34390 STUDY OF WAVES IN THE EARTH'S BOW SHOCK. Holzer, Robert E.; (Univ. of California, Los Angeles); Northrop, Theodore G.; Olson, John V.; Russell, Christopher T. J. Geophys. Res.; 77: No. 13, 2264-73(1 May 1972).

The perturbation vectors of waves upstream and downstream from the region of maximum compression in the bow shock were examined on Ogo 5 under particularly steady solar-wind conditions. The polarization of the upstream wave was right-hand circular, and that of the downstream waves left-hand elliptical in the spacecraft frame. By observing that the polarization of the waves remained unchanged as the shock motion swept the wave structure back and forth across the satellite 3 times in 8 min, it was found that the waves were not stationary in the shock frame. A study of the methods of determining the shock normal indicates that the normal estimated from a shock model should be superior to the normal based on magnetic coplanarity. The propagation vectors of the waves examined did not coincide with the shock-model normal, the average magnetic field, or the plasma-flow velocity. However, the major axis of the polarization ellipse of the downstream wave was nearly parallel to the upstream propagation vector. (auth)

34391 PLASMA WAVES IN THE DAYSIDE POLAR CUSP. I. MAGNETOSPHERIC OBSERVATIONS. Scarf, F. L. (TRW Systems Group, Redondo Beach, Calif.); Fredricks, R. W.; Green, I. M.; Russell, C. T. J. Geophys. Res.; 77: No. 13, 2274-93(1 May 1972).

A general survey is presented of the Ogo 5 plasma-wave measurements for the dayside polar-cusp encounters of November 1, 1968, and a detailed analysis of the observations at the low-altitude ($r \simeq 3$ to 5 R_E) cusp boundaries. The survey section contains an over-all discussion of the ulf magnetic-field wave levels and the vlf electric-field amplitude ranges measured from perigee out to 9 R_E on November 1, 1968. These cusp-associated observations are compared with those made on October 27 and November 6, 1968. These cusp-associated observations are compared with those made on October 27 and November 6, 1968, when Ogo 5 traversed the dayside magnetosphere without encountering the cusp. At the November 1 low-altitude cusp boundaries, it is shown that intense wave levels were detected over a broad spectral region at the steep gradients in cusp plasma density and thermal energy. The results are interpreted in terms of drift instabilities for low-β plasmas with hot ions, and associated wave–particle and wave–wave interactions are briefly discussed. (auth)

34392 DAYSIDE AURORAL-OVAL PLASMA DENSITY AND CONDUCTIVITY ENHANCEMENTS DUE RO MAGNETOSHEATH ELECTRON PRECIPITATION. Kennel, C. F. (Univ. of Colorado, Boulder. National Center for Atmospheric Research, Boulder, Colo.); Rees, M. H. J. Geophys. Res.; 77: No. 13, 2294-2302 (1 May 1972).

Magnetosheath electrons precipitating into the dayside auroral oval are a significant source of ionization and consequently will lead to electric conductivity enhancements within the oval. By assuming that the electrons are maintained isotropic by strong pitch-angle diffusion as they precipitate into the ionosphere, the precipitation heat flux can be simply related to solar-wind energy density and consequently to the level of magnetic activity. For quiet solar-wind conditions, the heat fluxes of 1 to 10 ergs cm^{-2} sec^{-1} expected and observed lead to height-integrated Pedersen conductivity enhancements of 4 to 15 mhos. During magnetic storms the conductivity enhancements could increase by a factor of 3 to 5. Since the precipitating electrons are soft, the Hall conductivity enhancements are smaller than the Pedersen conductivity enhancements. For typical electric fields the computed conductivity enhancements lead to field-aligned currents bounding the enhancements in order-of-magnitude agreement with observation. The topside ionosphere should also have a density enhancement over the auroral oval on the dayside. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 34267, 35158, 35211, and 35315.

34393 (CEA-R--4213) STUDY, BY SIMPLE AND DOUBLE EXTRACTION OF PURE AND SEEDED SUPERSONIC JETS, OF THE EFFECTS PRESENT IN THE FORMATION OF A HIGH-INTENSITY MOLECULAR BEAM OF ENERGY IN THE RANGE 0 TO 25 eV. Campargue, Roger (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jan 1972. 246p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ., France.

The shock-wave system of a free jet, produced in a region where the pressure P_1 is in the range of 10^{-2} up to 1 torr, is partly invaded by background molecules, these latter being pumped and carried by the supersonic flow. When a gas mixture is introduced into the nozzle chamber and outside the shock barrel, this aspiration acts very selectively on the light molecules and a mixture enriched in lighter species is attainable by skimming the free jet. This new aerodynamic separation effect, which is applicable to isotopic mixtures, is very effective in comparison with the efficiency of an elementary gas diffusion membrane. The invasion of the free jet by background molecules is reduced either by decreasing P_1, the pressure in the expansion chamber, or by increasing the nozzle stagnation pressure P_0 even when, in the latter case, P_1 is simultaneously increasing. This absolute pressure effect provides a new way of improving the intensity and energy of nozzle beams. However, this improvement is limited by skimmer jet interaction (which can be reduced by a careful choice of geometrical parameters) and other effects (scattering and self-scattering) occurring downstream from the skimmer. In spite of these limitations, it is possible to produce, with relatively low pumping rates, molecular beams with high Mach numbers ($15 < M < 20$), high intensity (10^{19} to 3×10^{20} mol.ster.$^{-1}$s^{-1}) and intermediate energies (11 eV with $T_0 \approx 900$°K). (auth)

34394 (SC-T--722497) SELF-CONSISTENT MODEL OF A TUBULAR FLOW OF ELECTRONS. Voronin, V. S.; Lebedev, A. N. Translated by Patricia Newman (Sandia Labs., Albuquerque, N. Mex.), from Kratk. Soobshch. Fiz.; No. 5, 39-46(1971). 10p. Dep. NTIS.

The distribution of charge density and current density in a tubular flow of electrons is investigated. The particles are assumed to move between two cylinders of radius r_1 and $r_2 > r_1$ along spiral trajectories. The radial coordinates of the electrons fluctuate between r_1 and r_2 under the influence of the self-consistent electric and magnetic field of the beam and the field of fixed ions. (M.O.W.)

34395 CONNECTION JOINT IN A HEATED VAPOR DUCT OF AN ION SOURCE. Ignat'ev, V. N.; Naumkin, V. P. Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 835-6(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 156-7(May-Jun 1971).

Construction of a hermetically sealed connection joint of metallic pipes which was used in feeding Bi vapors into an ion source is described. (auth)

34396 MOLECULAR BEAMS OF SHORT LIVED RADIOACTIVE NUCLIDES. II. PREPARATION OF BEAMS BY WALL REACTIONS. Grover, J. Robb; Lilenfeld, Harvey V. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum.; 43: No. 4, 690-2(Apr 1972).

To prepare beams of atomic astatine-217 ($T_{1/2} = 0.032$ sec), gaseous $H^{217}At$ is conducted into a specially shaped platinum tube held at 1000°C. Experiments for identification of the beam are described, and intensity data are given. (auth)

34397 FINE METAL ION SOURCE. Kishi, Tohru; Sugata, Eizi (Osaka Univ.). Jap. J. Appl. Phys.; 11: No. 5, 773-4 (May 1972).

A method for production of ions by bombardment of a metal surface by a high-power-density electron beam is described. The ions are extracted by a negative electric field. Metals used in experiments were Se, Zn, and Si. A Gaussian distribution of the ion current and a total current of 0.30 μA were obtained. The ion beam was focused by a static lens of unipotential type to produce a minimum spot size of 0.6 mm. (A.G.W.)

34398 ELECTRON GUN FOR AUGER AND ULTRASOFT X-RAY APPARATUS. Pessa, V. M. (Univ. of Turku, Finland). Acta Polytech. Scand., Phys. Nucl. Ser.; No. 84, 1-16(1971).

A small-size electron gun with four electrodes was constructed especially for Auger and ultrasoft x-ray instruments. The gun produces a roughly parallel electron beam with high intensity at constant potentials between 0.5 and 6 keV. The beam has, in this energy range, an intense core of about 1 mm in diameter. An optical bench is used as a framework in the construction of the gun. All critical lens parameters as well as constructional details are given. The potential of the third electrode giving the maximum beam current is found to depend linearly on the beam energy, which makes operation of the gun convenient. The two other electrodes are maintained at constant voltages. (auth) (Finland)

34399 PHOTON EMISSION DURING BOMBARDMENT OF SOLIDS WITH ALKALI IONS IN THE ENERGY RANGE BETWEEN 2 AND 10 keV. Kerkow, H. (Humboldt Univ., Berlin). Phys. Status Solidi (a); 10: No. 2, 501-8(16 Apr 1972).

Experimental results are reported regarding the emission of photons by the bombardment of solids with 2- to 10-keV alkali ions. The results on spatial and spectral distribution are interpreted with respect to a sputtering mechanism. In this process, sputtered particles are excited and emitted by atomic collisions with the projectile ion. Outside of the solid in front of the surface, the excited particles interact electronically with the surface and recombine radiatively into deeper electronic states. So the higher photon yields for insulators and semiconductors with regard to metals can be explained. An attempt was made to interpret the spatial distribution of photon emission. (auth)

34400 ENERGY DISPERSED NEUTRAL BEAMS. Barnett, C. F.; Ray, J. A. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum.; 43: No. 1, 29-31(Jan 1972).

Energy-dispersed neutral hydrogen beams were obtained by passing H^+ or H_2^+ through an argon gas cell. The gas cell was composed of an 11-electrode ceramic structure across which a retarding potential was placed. Neutrals formed had an energy characteristic of the equipotential line on which the electron capture collision occurred. Flat energy distributions were obtained with linear retarding potentials. (auth)

34401 MULTIAMPERE DUOPIGATRON ION SOURCE. Davis, R. C.; Morgan, O. B.; Stewart, L. D.; Stirling, W. L. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum.; 43: No. 2, 278-83(Feb 1972).

An ion source consisting of a duoplasmatron feeding a PIG discharge system was built and is named a duoPIGatron. The extraction electrodes, located at the end of the PIG discharge opposite the duoplasmatron, are accel--decel with a 5 cm diam and multiapertures. The source is simple, flexible, and efficient. One-ampere beams are extracted in steady-state operation with ion energies from 1.5 to 5 keV. Four-ampere beams are extracted with 0.1-sec pulses and a 10% duty cycle at ion energies of 20 to 40 keV. At 30 to 40 keV, about 60% of the ion beam is within a half-angular divergence of 1.2°, with no magnetic lens. Using a hydrogen gas cell, this system produces 2.6 A (equivalent) of 17.5- and 35-keV H^0 particles within a half-angular divergence of 1.2°. One of the present limitations in scaling the source to larger beams is the current capabilities of the power supplies. As larger supplies are available, attempts will be made to scale this system to the 10-A beam modules needed for future fusion research. (auth)

34402 DOUBLE-SCATTERING MECHANISM TO ACCOUNT FOR THE Si K-X-RAY YIELDS OBSERVED DURING ARGON-ION BOMBARDMENT OF SILICON. Macek, Joseph (Univ. of Nebraska, Lincoln); Cairns, J. A.; Briggs, J. S. Phys. Rev. Lett.; 28: No. 20, 1298-1301(15 May 1972).

Si K x rays are observed when solid Si is bombarded by 160- to 260-keV Ar^{++} ions. The production of such x rays is interpreted in terms of the Fano--Lichten model and a double-scattering mechanism whereby Si K vacancies are produced by electron promotion to an Ar $L_{2,3}$ vacancy formed in a prior collision. (auth)

34403 STUDY OF THE LIGHT EMITTED BY EXCITED ION BEAMS PASSING THROUGH A THIN FOIL. Dumont, P. D. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 7, 855-71(1971). (In French).

The principle of the method and the main properties of the light emitted by excited ion beams passing through a thin foil are reviewed. The preliminary results obtained with nitrogen beams are given. (auth) (Belgium)

34404 ANGULAR AND ENERGY DISTRIBUTION OF ELECTRONS INELASTICALLY REFLECTED FROM SOLIDS. Bronshtein, I. M.; Stozharov, V. M.; Pronin, V. P. (Leningrad State Pedagogical Inst.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2821-6(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3359-65(Nov 1971).

The angular distribution of inelastically reflected electrons and their energy distribution are investigated in a narrow solid angle for Be and Pb in the range of primary electron energies $E_p = 0.3$ to 3 keV, and in the range of angles of incidence φ of the electrons on the target from zero to 85°. It is shown that for Be, for $\varphi = 0°$, independently of E_p, and for Pb, for small E_p, the inelastically reflected electrons have an approximately cosine distribution, due to the diffuse nature of the electron motion. As φ and E_p increase, due to small-angle Rutherford scattering of the electrons in Be, the polar diagram of the angular distribution is elongated approximately in the direction of specular reflection. For Pb, in addition, for all E_p as φ increases, a group of electrons appears which is scattered at large angles, obviously due to single collisions with the atoms of lead (for $\varphi = 85°$ the relative fraction of these is 20%). The energy of these electrons, as also of the electrons scattered at small angles, is larger than the energy of the electrons scattered in other directions. (auth)

34405 BACKSCATTERING OF HYDROGEN AND RARE GAS IONS FROM METAL SURFACES. Eckstein, W.; Verbeek, H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). J. Vac. Sci. Technol.; 9: No. 2, 612-15(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Energy and angular distributions of H_1^+, Ne^+, and Ar^+ backscattered from polycrystalline Nb and W targets were measured. The bombarding energy used was 15 keV. The pressure in the target region during bombardment was kept below 2×10^{-9} torr. An electrostatic spherical condenser was used as an energy spectrometer. Surface impurities were detected by observing the binary scattering peaks of Ne^+. The shape of the energy spectra of backscattered protons depends strongly on the surface cleanness and on the crystalline structure of the target. (auth)

34406 CHARACTERISTIC X-RAY PRODUCTION BY HIGH ENERGY OXYGEN IONS. Burch, David Francis. Austin, Tex.; Univ. of Texas (1971). 118p. University Microfilms Order No. 72-15,720.

Thesis.

High-resolution Si(Li) detectors were used to study the production of K and L x-rays by incident oxygen ions with energies E = 7.5 to 40 MeV. K x ray energies and relative intensities for elements with atomic number Z = 13 to 60 and L x-rays from elements Z = 29 to 70 were measured. The x ray energies are found to be, systematically with Z and E, shifted to higher energies, the observed line widths broadened, and the relative intensities altered when compared to the same x rays produced by fluorescence or proton bombardment. Insight into the origin of these effects was gained from Hartree–Fock–Slater calculations of the x ray transition energies and relative intensities for atoms in various states of ionization. It was found that only a fairly restrictive set of inner-shell vacancy configurations, present at the time of x-ray emission, could account for the observations. These configurations are nearly independent of the simultaneous state of outer-shell ionization and, further, no degree of outer-shell ionization alone can explain the data. This interpretation of the data was reinforced by higher-resolution measurements using a single-crystal Bragg spectrometer of the Fe Kα x rays produced by 30-MeV 0^{5+}. The previously measured broad, shifted line was found to consist of n resolvable components that could be identified as originating from a $(1s)^{-1}$ $(2p)^{-n}$ $(3p)^{-m}$ initial-state configuration with n = 0, 1, 2, (3) and m ~ 2 or 3. These identifications were based upon the transition energies, considerations of the L-shell nonradiative transition rates for defect configurations, measured $K\alpha/K\beta$ intensity ratios, and arguments concerning the primary vacancy production in the L subshells. The occupation of the 3d-shell could not be determined from these measurements but can be estimated, if assumptions are made concerning the 2p Auger transition probabilities involving electrons from that shell. To provide a means of preliminary analysis for related measurements, Mosley-type diagrams for K and L x rays from defect configurations $(2p)^{-n}$ $(2p)^{-m}$ with n, m = 0 to 5, were calculated for Z = 10 to 80. For K x rays, relative intensities were also calculated for these configurations. In an attempt to gain some understanding of the atom–ion interaction that results in such high degrees of inner-shell ionization, the absolute cross sections for K x-ray production in Al, Ca, and Cu were measured as a function of incident ion energy. After developing methods for estimating the effective fluorescence yields in defect configurations, these cross sections are compared to two theoretical models based upon an impulse approximation and a plane-wave Born approximation. It is found that these simple models alone are not adequate and approximate numerical treatments of several possible corrections to these models are presented. It is subsequently concluded that the K-shell ionization can be described by a direct Coulomb interaction between the incident oxygen nucleus and the K-shell electron. That is, there is no evidence from the x-ray production studies thus far carried out, that the atomic structure of the incident ion affects the K-shell ionization. There is, at present, no theoretical model that can account for the multiple L-shell ionization for the atom–ion systems and energies studied here. Speculations concerning these matters are presented. (Diss. Abstr. Int., B)

34407 MEASUREMENT OF PRIMARY ELECTRON INTERACTION COEFFICIENTS (500 TO 1500 eV REGION. Henke, Burton L. (Univ. of Hawaii, Honolulu). J. Phys. (Paris), Colloq.; No. 4, 115-23(1971).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

Because incident electrons in the 500- to 1500-eV energy range interact appreciably with only a few atomic layers in solids, accurate measurement and applications of the interaction coefficients are difficult. The statistics of the interaction and the sensitivity to the geometric arrangement of the target atoms require special attention. A method of studying such reactions is presented; it is based upon targets formed by the controlled deposition of a monoatomic layer of divalent metallic cations on a substrate consisting of a Langmuir Blodgett type stearate double layer. The cross sections of Ba cations at 466, 706, and 1349 eV and those of Zn and Pb at 706 eV were measured in order to verify the method. The measured values agree with recent measurements made with an atomic beam incident on Ba, and also with a simple theoretical model. Measurements of this type are of great importance in the development of quantitative surface chemical analysis using electron spectroscopy and low-energy x rays. (France)

34408 ENERGY DISTRIBUTIONS OF LIGHT IONS SCATTERED BY SOLID SURFACES. Mashkova, E. S.; Molchanov, V. A. (Moscow State Univ.). Radiat. Eff.; 13: No. 1-2, 131-5(Mar 1972)

The energy and angular dependences of the energy distributions of 10 to 30-keV helium ions scattered by solid targets were studied. It was found that when the primary helium ion energy is high enough, the energy distributions of the scattered ions are broad and cupola-shaped. At the high-energy edge of the distributions, a narrow single peak was observed. It was found that the half-widths of the energy distributions depend strongly upon both sliding and scattering angles, upon the atomic number of the target substance, and upon the energy of the primary ions. The observed data are discussed in terms of the so-called "single deflection model," taking into account the neutralization probability of the ions. (auth)

Atomic and Molecular Properties

Refer also to abstracts 33185, 33386, 34161, 34162, 34473, 34475, 34480, 34482, 34484, 34705, 34713, 34931, 34955, 34980, and 35107.

34409 (NP–19292) LINE PROFILE OF THE $Q_{01}(1)$ VIBRATIONAL RESONANCE IN H_2 IN THE ZONE OF DICKE NARROWING. Note No. 349. De Martini, F.; Giuliani, G. P.; Santamato, E. (Rome Univ. (Italy). Istituto di Fisica). 30 Nov 1971. 11p. Dep. NTIS (U. S. Sales Only).

A new method of high-resolution nonlinear spectroscopy based on the detection of the anti-Stokes intensity arising from a resonant four-photon coherent interaction is applied to the determination of the line profile of the Raman resonance $Q_{01}(1)$ in hydrogen gas. The real part as well as the imaginary part of the nonlinear Raman susceptibility was observed in a thermodynamical condition for the gas in which the Dicke-narrowing process and the dephasing collision-broadening effect determine competitively the shape of the resonance line. (auth)

34410 LEVEL-CROSSING EXPERIMENTS IN THE Tm I SPECTRUM. Wallenstein, R. (Technische Univ., Hanover). Z. Phys.; 251: No. 1, 57-70(1972). (In German).

The lifetimes of 14 levels of the Tm I spectrum were measured using the technique of zero-field level crossing. For three Tm I levels the hyperfine splitting of ^{169}Tm was measured by investigating the level crossings at finite values of the magnetic field. Using the eigenvectors derived by Camus, the measured lifetimes are discussed and the radial integrals I(6s, 6p) and I(4f, 5d) for the electric dipole transitions from the excited levels belonging to the configurations $4f^{13}6s6p$ and $4f^{12}5d6s^2$ to the ground state (configuration: $4f^{13}6s^2$) are calculated. The results are compared with theoretical values computed from Hartree–Fock wave functions (Camus, J. Phys. Radium, 27: 717(1966)). (auth)

34411 STRUCTURE OF THE 2^3P–2^3S_1 OPTICAL TRANSITION OF ^{3}He: A STUDY BY EMISSION AND ABSORPTION SPECTROSCOPY. Timsit, R. S.; May, A. D. (Univ. of Toronto). Can. J. Phys.; 50: No. 2, 67-72(15 Jan 1972).

The intensity and frequency of the hyperfine components of the 1.083-μ transition in ^{3}He are studied. A discrepancy between the calculated relative intensities and the intensities observed in both emission and absorption is noted. The measured frequencies are in excellent agreement with the calculated values. (auth)

34412 ZERO-FIELD LEVEL CROSSING IN THE HELIUM ATOM. Chien, C. W. T.; Bardsley, R. E.; Dalby, F. W. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 50: No. 2, 116-18(15 Jan 1972).

Zero-field level-crossing techniques were used to measure some upper-state lifetimes of the helium atom. The half-widths of curves obtained by plotting the polarization against the magnetic field strength for the n^1D-2^1D transitions yielded lifetimes of 2.03×10^{-8} s for the 3^1D state, 3.36×10^{-8} s for the 4^1D state, and 7.44×10^{-8} s for the 5^1D state. Collision cross sections for these ^1D levels were also determined. (auth)

34413 CALCULATION OF FINE-STRUCTURE SPLITTINGS AND QUADRUPOLE ANTISHIELDING FACTORS FOR ATOMIC STATES. Sternheimer, R. M.; Peierls, R. F. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., A; 4: No. 5, 1722-8 (Nov 1971).

As a test of accurate valence wave functions previously obtained for the excited np states of the alkali atoms, the fine-structure splittings $\Delta\nu$ were calculated using these wave functions. The resulting values of $\Delta\nu_{\text{theor}}$ are generally in good agreement with the corresponding experimental values $\Delta\nu_{\text{expt}}$. The atomic quadrupole shielding factor R for the ground states of boron (B 2p) and aluminum (Al 3p) and the ionic antishielding factor γ_∞ for the ions B^+, Al^+, and Al^{3+} also were calculated. The value of R(B 2p) = +0.048 is in good agreement with the results of calculations using spin-polarization wave functions. The result for R(Al 3p) = –0.063 leads to a corrected value of the nuclear quadrupole moment $Q(^{27}Al) = 0.140 \pm 0.002$ b, using the atomic-beam result of Lew and Wessel. The ionic antishielding factors γ_∞ have the following calculated values: $\gamma_\infty(B^+) = +0.773$, $\gamma_\infty(Al^+) = -1.68$, and $\gamma_\infty(Al^{3+}) \cong -2.4$. (auth)

34414 RELATIVISTIC CONTRIBUTION TO THE HYPERFINE INTERVAL OF THE METASTABLE TRIPLET STATE OF ^{3}He. Druzbick, John (American Univ., Washington, D. C.); White, John A.; Sessler, Andrew M. Phys. Rev., A; 5: No. 6, 2683-4(Jun 1972).

The relativistic correction to the hyperfine-structure splitting of the metastable $2\ ^3S_1$ state of ^{3}He, first calculated by Sessler and Foley to be 315 ± 3 ppM, is reevaluated as $\Delta_{\text{rel}} = 327 \pm 3$ ppM. Using this new value, the theoretical ratio of the hyperfine splitting in the $2\ ^3S_1$ state of ^{3}He to the hyperfine splitting in the $2\ ^2S_{1/2}$ state of He^{3+} becomes $\rho_{\text{th}} = 6.2211911 \pm 0.0000187$. The experimental value for the ratio is 6.2211384 ± 0.0000012, and the 8 ± 3 ppM discrepancy is presently unexplained. (auth)

34415 L X-RAY TRANSITION PROBABILITIES IN ELEMENTS OF MEDIUM AND HIGH ATOMIC NUMBERS. Salem, S. I.; Clark, D. C.; Tsutsui, R. T. (California State Univ., Long Beach). Phys. Rev., A; 5: No. 6, 2390-5(Jun 1972).

The $L\gamma_2/L\beta_3$, $L\gamma_3/L\beta_3$, $L\eta/L\beta_1$, $L\beta_5/L\alpha_1$, $L\beta_6/L\alpha_1$, and $Ll/L\alpha_1$ radiative-transition probability ratios were measured for 13 elements ranging in atomic number from ^{62}Sm to ^{92}U. This was accomplished by bombarding the elements with an electron beam of constant energy and flux and counting the x-ray photons emitted by a given electronic transition. The corrected measured ratios are compared with the results calculated on the basis of the relativistic Hartree–Fock–Slater (RHFS) potential and those calculated on the basis of the relativistic screen-Coulomb (RSC) potential. In general, values calculated on the basis of the RHFS potential are favored except for the $Ll/L\alpha_1$ ratio where the measured values and those obtained from RSC-potential calculations are in excellent agreement and are as much as 40% lower than the values obtained assuming a RHFS potential. The $L\gamma_2/L\beta_3$ and $L\gamma_3/L\beta_3$ values obtained with a RSC potential are as much as an order of magnitude greater than experimental values at high Z and are not included in the graphs. The estimated error of the experimental results is from 10 to 15%. Other experimental values are also included for comparison. (auth)

34416 DETERMINATION OF THE ISOTOPE SHIFT OF $g_J/(H)_J(D)$. Hughes, William Michael. Durham, N. C.; Duke Univ. (1970). 177p. University Microfilms Order No. 71-10,386. Thesis.

Precision measurements on hydrogen, deuterium, rubidium, and cesium using optical pumping and the electron spin-exchange technique are reported. The high precision realized was due primarily to the homogeneity and stability of the applied magnetic field coupled with the advantages of evacuated wall-coated cells. Ground-electronic-state Zeeman transitions exhibited frequency shifts as a function of pumping light intensity. Thus, extrapolation to zero light intensity was necessary. The earliest experiments were done in order to complete investigations of $g_I/g_J(^{85}Rb)$, (^{87}Rb), and (^{133}Cs) and $g_J(^{133}Cs)/g_J(^{87}Rb)$. The final results are $-g_I/g_J(^{85}Rb) = 1.466\ 490\ 8 \times (1 \pm 2.1 \times 10^{-6}) \times 10^{-4}$, $-g_I/g_J(^{87}Rb) = 4.969\ 914\ 7 \times (1 \pm 0.9 \times 10^{-6}) \times 10^{-4}$, $-g_I/g_J(^{133}Cs) = 1.991\ 739\ 7 \times (1 \pm 1.4 \times 10^{-6}) \times 10^{-4}$, and $g_J(^{133}Cs)/g_J(^{87}Rb) = 1.000\ 104\ 474\ 7 \times (1 \pm 3.8 \times 10^{-9})$. Later experiments determined $g_J(^{87}Rb)/g_J(H)$, $g_J(^{87}Rb)/g_J(D)$, and $g_J(H)/g_J(D)$. The results are $g_J(^{87}Rb)/g_J(H) = 1.000\ 023\ 585\ 8 \times (1 \pm 0.7 \times 10^{-9})$, $g_J(^{87}Rb)/g_J(D) = 1.000\ 023\ 592\ 7 \times (1 \pm 1.0 \times 10^{-9})$, and $g_J(H)/g_J(D) = 1.000\ 000\ 006\ 9 \times (1 \pm 1.3 \times 10^{-9})$. The hyperfine separation of the ground state of D, $\Delta\nu$(D), in the Al time scale was also determined: $\Delta\nu(D) = 327\ 384\ 352.9 \pm 1.5$ cps. Finally, the first known determination of g_I/g_J for the free D atom is reported: $g_I/g_J(D) = 2.332\ 173 \times (1 \pm 4.3 \times 10^{-6})$. An indirect determination of $\Delta\nu$(H) in the Al time scale is $\Delta\nu(H) = 1\ 420\ 405\ 575 \pm 15$ cps. The most interesting of all of these determinations is $g_J(H)/g_J(D)$, which exhibits an isotope shift. A theory for this shift has recently been developed (Hegstrom, 1969). Comparison with theory and experiment indicated that corrections to the theory may be required or that unknown systematic effects are present in the experiment. (Diss. Abstr. Int., B)

34417 SPONTANEOUS RADIATIVE DISSOCIATION IN MOLECULAR HYDROGEN. Stephens, T. L.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Quant. Spectrosc. Radiative Transfer; 12: No. 4, 569-86(Apr 1972).

The spontaneous radiative dissociations of the discrete vibrational levels of the $B^1\Sigma_u^+$ electronic states of H_2, HD, and D_2 of the $C^1\Pi_u$ electronic state of H_2 into the vibrational continuum of the ground $X^1\Sigma_g^+$ state are calculated as a function of the emission wavelength. The fluorescent spectra of HD in the Lyman system and of H_2 in the Werner system resulting from an excitation source uniform in wavelength are predicted. The vibrational radiative lifetimes are tabulated as are the fractions of radiative decays that lead to dissociation. The effects of centrifugal distortion are discussed briefly. An appendix describes a sum rule used to check the numerical accuracy of the calculations. (auth)

34418 ZERO FIELD LEVEL CROSSING IN EXCITED STATES OF MOLECULAR HYDROGEN. Van Der Linde, J.; Dalby, F. W. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 50: No. 3, 287-97(1 Feb 1972).

Zero-field level-crossing effects were observed in the lines emitted from the J = 1, 2, and 3 rotational levels of the 3d $^1\Sigma_g^+$ (v = 0) state of molecular hydrogen excited in an rf discharge. The polarization of the R(0), R(1), and R(2) lines of the 3d $^1\Sigma \rightarrow$ 2p $^1\Sigma(0 \rightarrow 0)$ band as a function of magnetic field was observed to be Lorentzian, and using the Landé g factors measured by Dieke et al. yields radiative lifetimes of 2.66×10^{-8} s, 3.83×10^{-8} s, and 3.93×10^{-8} s for J = 1, 2, and 3 respectively. The half-width of the level-crossing curves was observed to vary linearly with pressure in the range 15 to 90 m torr and yield collision cross sections of ≃ 150 Å^2 for all three states. The source of the discrepancy between the first and the latter two lifetimes is discussed. The lifetime of the J = 2, 3d $^1\Pi$ state was also measured with less precision and was found to be 3.84×10^{-8} s. (auth)

34419 DETERMINATION OF A STATIC HYPERFINE INTERACTION FOLLOWING RECOIL INTO VACUUM. Dar, Y. (Technion-Israel Inst. of Tech., Haifa); Engelstein, P.; Gerber, J.; Levy, R.; Vivien, J. P. Z. Naturforsch.; 27a: No. 4, 562-5(Apr 1972).

By means of using a plunger time-differential technique, spin precessions from a static-free hyperfine interaction were observed for low-energy ^{152}Sm nuclei recoiling into vacuum. (auth)

34420 Y IV TRANSITIONS TO THE GROUND LEVEL. Chaghtai, M. S. Z.; Ali, Zahid; Yadav, H. L. (Muslim Univ., Aligarh, India). Indian J. Phys.; 45: No. 1, 28-33(Jan 1971).

Using a sliding spark source, the yttrium spectrum is recorded in the extreme ultraviolet. Seventeen transitions to the ground level from $ns^{13}P_1$(n = 5 to 7), nd^1P_1(n = 4 to 6), nd^3D_1, and nd^3P_1(n = 4 to 7) are reported. The ionization potential $4p^{61}S_0$–

$4p^5\,{}^2P_{1/2}$ is evaluated to be 489700 cm^{-1} with the help of a 3-parameter Ritz formula. (auth)

34421 STARK PROFILE OF THE Ly-α LINE IN THE TRANSITION REGION FROM COLLISIONAL TO QUASISTATIC BROADENING. Lisitsa, V. S.; Sholin, G. V. J. Quant. Spectrosc. Radiative Transfer; 12: No. 5, 985-8(May 1972). (In Russian).

Theoretical work on spectral line broadening has recently centered upon descriptions of the contour of the hydrogen lines in the transition region from the collision to the quasi-static limit. Normally this description is based on some procedure of interpolation between the two limits, but Spitzer (1940) showed that for the Ly-α line an exact solution of the broadening problem is possible. Here the profile of the Ly-α line as obtained by the exact theory is compared both with the results of calculations based on interpolation and with experimental results. (UK)

34422 ADIABATIC APPROACH TO THE THEORY OF THE STARK-BROADENING OF HYDROGEN LINES. Kogan, V. I.; Lisitsa, V. S. J. Quant. Spectrosc. Radiative Transfer; 12: No. 5, 881-93(May 1972). (In Russian).

The adiabatic theory for the Stark broadening of hydrogen spectral lines is used to represent the transitional frequency region between the impact and quasi-static limits. The choice of a single system for such a representation is based on an analysis of a number of general results obtained by various authors on the basis of the adiabatic model. The interconnection between the principal approaches used in the theory of broadening is discussed, viz., multiplicity, binarity, "one-electron" nature, the vectoral and scalar nature of the addition of perturbations, etc. The results of the calculations are found to be in good agreement with the semi-empirical results of Schlieter (1968) and those from the well-known experiments of Boldt and Cooper (1964) and of Elton and Griem (1964). It is further shown that the adiabatic theory provides a useful basis for representing the shapes of hydrogen lines, not only in the far wings but also over the wide transitional range of frequencies. An important feature of the adiabatic approach used is its universal nature (a single analytic structure for all lines), which enables the experimentally observed universal nature of the transition from the impact limit to the quasi-static limit to be explained. (tr-auth)

34423 CONVERGENT THEORY OF SPECTRAL LINE BROADENING IN THE IMPACT APPROXIMATION. Dyne, R. J.; O'Mara, B. J. (Univ. of Queensland, Australia). Astron. Astrophys.; 18: No. 3, 363-72(May 1972).

In the impact theory of spectral-line broadening, the width and shift of a line are expressed in terms of integrals over the collision impact parameter. In the theory of Griem et al. (1962), the integrands in the width and shift expressions diverge at small impact parameters. This requires the introduction of a cutoff value of the impact parameter in the calculations. The method of Vainshtein and Sobel'man (1959) is investigated. This method results in integrands which do not diverge at small impact parameters and widths and shifts which satisfy the dispersion relation of Griem and Shen (1962). Certain errors in the original work of Vainshtein and Sobel'man are corrected. The Griem, Baranger, Kolb and Oertel, and the Vainshtein—Sobel'man theories are compared in detail in the two-level approximation. Multilevel calculations were carried out for two spectral lines using both theories. Differences of the order of 15% were found. The Vainshtein—Sobel'man method was used to calculate the widths and shifts of a number of lines of neutral helium, and these are compared with experiment. A marginal improvement in the agreement between theory and experiment was found. (auth)

34424 STARK BROADENING OF LYMAN-β. Bacon, M. E. (Univ. of Natal, Durban, South Africa). J. Quant. Spectrosc. Radiative Transfer; 12: No. 4, 519-23(Apr 1972).

Classical-path calculations for the Stark broadening of the Lyman-β line of hydrogen are presented using a procedure outlined previously (Bacon et al., Phys. Rev., 188: 50(1969). All multipoles in the perturber (free electron)—atom interaction are included and time ordering of the operators in the S matrices is retained. Comparison is made with previous calculations. In particular, the profiles given here have very nearly the same half widths as the profiles of Kepple and Griem (1968) but show a significant increase in the intensity at the line center. (auth)

34425 SHORT-LIVED RESONANT STATE OF H^{2-}. Taylor, Howard S. (Univ. of California, Los Angeles); Thomas, Lowell D. Phys. Rev. Lett.; 28: No. 17, 1091-2(24 Apr 1972).

A short-lived resonant state with configuration $(2s)^2(2p)\ {}^2P^0$ is computed for H^{2-} using the stabilization method. The resonant energy is 14.8 eV and the estimated width is roughly 1 eV, all in excellent agreement with experiment. (auth)

34426 EFFECT OF NUCLEAR MASS ON THE BOUND-ELECTRON g FACTOR. Walther, Frederick G.; Phillips, William D.; Kleppner, Daniel (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 28: No. 18, 1159-61(1 May 1972).

The effect of nuclear mass on the g factor of the bound electron was determined by measuring $G = g_j(H)/g_j(D)$ to a precision of 3×10^{-11} using a pulsed double-mode hydrogen maser. The result, $G = 1 + (7.22 \pm 0.03) \times 10^{-9}$, is in excellent agreement with the theory of Grotch and Hegstrom (Phys. Rev., A4: 59(1971)). (auth)

34427 IONIC SOFT-SPHERE PARAMETERS FROM HARTREE—FOCK—SLATER CALCULATIONS. Butterfield, Charles; Carlson, Edward H. (Michigan State Univ., East Lansing). J. Chem. Phys.; 56: No. 10, 4907-11(15 May 1972).

The soft-sphere parameters for many closed-shell ions from He through U^{6+}, as well as many ions of the 3d, 4d, 5d, and 4f transition series, were computed from charge densities obtained from Hartree—Fock—Slater calculations. For each ion, a radius R_0 at which the charge density ρ_c is exp (−4.3) au and a softness ρ, which appears in $\ln(\rho_c) = -4.3 + (R_0 - r)/\rho$, were obtained. These characterize the charge density in the outer region of the ion, that is, on the order of 0.5 electrons lie outside a sphere of radius R_0. In addition, an electron affinity A was computed for each ion, being taken as the ionization potential for the ion with one added electron. Use of these parameters in semiempirical theories of ionic crystals, such as the Born—Mayer theory of hard-core repulsive forces and the soft sphere model of electric field gradients at nuclei, is briefly discussed. (auth)

34428 STATIC CHARGE DISTRIBUTIONS WHICH GENERATE EXACT POTENTIAL CURVES FOR DIATOMIC MOLECULES. Parr, R. G.; Finlan, J. M.; Schnuelle, G. W. (Johns Hopkins Univ., Baltimore). Chem. Phys. Lett.; 14: No. 1, 72-3(1 May 1972).

For a diatomic molecule, there exists a charge density that can be used to generate the exact potential energy curve for the molecule, by integration of the classical Poisson equation. This density is displayed for H_2^+, H_2, and LiH, and it is shown to be similar in shape to the united-atom electron density. (auth)

34429 MULTIPHOTON IONIZATION OF DIFFERENT ORDER FROM EXCITED STATES OF THE He ATOMS IN A GLOW DISCHARGE. Bakos, J.; Kiss, A.; Szabo, L.; Tendler, M. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 39A: No. 4, 317-19(22 May 1972).

Multiphoton ionization of different order was measured from the energy levels of the He atoms excited in a low-current glow discharge. (auth)

34430 RESONANCE MULTIPHOTON IONIZATION OF THE TRIPLET METASTABLE He ATOMS. Bakos, J.; Kiss, A.; Szabo, L.; Tendler, M. (Central Research Inst. for Physics, Budapest). Phys. Lett.; 39A: No. 4, 283-4(22 May 1972).

The apparent number of quanta being absorbed in multiphoton ionization was measured to be higher than the theoretical value determined on the basis of conservation of energy. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 34661, 34933, and 35300.

34431 PRECISION EXPERIMENTS ON MUONIUM. I. DETERMINATION OF THE MUONIUM HYPERFINE SPLITTING IN LOW-PRESSURE ARGON FROM A FIELD-INDEPENDENT ZEEMAN TRANSITION. Ehrlich, R. D.; Hofer, H.; Magnon, A.; (and others) (Univ. of Chicago). Phys. Rev., A; 5: No. 6, 2357-75 (Jun 1972).

The ground-state hyperfine interval $\Delta\nu$ of muonium was redetermined in argon by measuring the $(1,1) \longleftrightarrow (1,0)$ Zeeman frequency ν_1 at that external field value where $\partial\nu_1/\partial B = 0$. The measurements were performed with good statistics at much lower pressures than heretofore, greatly reducing uncertainties in extrapolating to zero pressure. This value, $\Delta\nu(0) = 4463.313\ (18)$, disagrees with the linearly extrapolated values found in higher-pressure Ar and Kr by Crane et al. However, a new interpretation, namely, a pressure extrapolation based on a quadratic function with the linear coefficient fixed at the "atomic" value (i.e., assumption of no isotope dependence in the linear pressure shift), results in consistency between all present (data published before April 1971) determinations of $\Delta\nu$. (auth)

34432 MUONIUM. III. PRECISION MEASUREMENT OF THE MUONIUM HYPERFINE-STRUCTURE INTERVAL AT STRONG

MAGNETIC FIELD. Cleland, W. E.; Bailey, J. M.; Eckhause, M.; (and others) (Yale Univ., New Haven). Phys. Rev., A; 5: No. 6, 2338-56(Jun 1972).

A complete discussion is given of a precision measurement of the hyperfine-structure interval $\Delta\nu$ of the ground state of muonium at a strong magnetic field of 5000 G. Particular emphasis is placed on refinements to the theory of the resonance line shape and on a detailed discussion of the sources of error and of the capability of the method. The final result for $\Delta\nu$ is $\Delta\nu = 4463.24 \pm 0.12$ MHz (27 ppM), in which the 1-standard-deviation error is caused principally by the statistical counting error and magnetic field inhomogeneity. Allowance is included for a quadratic as well as a linear dependence of $\Delta\nu$ on pressure. This result is in good agreement with other, more precise, experimental values and with the current theoretical value $\Delta\nu = 4463.326 \pm 0.019$ MHz (4.2 ppM). (auth)

34433 K^--NUCLEUS OPTICAL POTENTIAL IN K^--MESONIC ATOMS. Seki, Ryoichi (San Fernando Valley State Coll., Northridge, Calif.). Phys. Rev., C; 5: No. 4, 1196-1205(Apr 1972).

Direct numerical calculations in K^--mesonic atoms showed that the perturbation theory commonly used is inadequate. The theory fails to describe the very strong repulsive (level-shift) effect due to the absorptive part of the optical potential. Because of this large repulsive effect, the optical potentials best fitted to the recent level-shift and width data are found to be attractive. The potential may be very attractive, but not enough to produce a K^-—nucleus bound state by the strong interaction against the strong repulsive effect of the large imaginary part: the latter works as if it were a hard core. By taking the 3d state of the K^-—^{32}S atom as a model, how well one can determine the nuclear-density parameters from the K^--mesonic-atom spectra within the optical-potential model is also examined. (5 figures, 3 tables) (auth)

34434 POSITRONIUM ANNIHILATION IN MOLECULAR SUBSTANCES. Tao, S. J. (New England Inst., Ridgefield, Conn.). J. Chem. Phys.; 56: No. 11, 5499-5510(1 Jun 1972).

The behavior of the Ps atom in molecular substances, particularly liquids, is investigated. The pickoff rates of o-Ps in various liquid compounds are found to have a simple empirical relationship to the values of the surface tension of the liquids. The relationship is found to have a theoretical foundation. The Ps atom is highly localized in a cavity created by the balance of various molecular forces inside the liquid. From the above relationship, other simple relationships between the pickoff rates of o-Ps and the various properties of the medium, e.g., polarizability, cohesive energy density, etc., and the temperature or pressure changes can be derived and explained. The diffusion of o-Ps is discussed. A similar approach can also be used for molecular solids. (auth)

Collision Phenomena

Refer also to abstracts 34310, 34425, and 34476.

34435 (LBL—474) REACTIVE AND INELASTIC SCATTERING OF MOLECULAR IONS. Chiang, Mervyn Ming-Hwa (California Univ., Berkeley. Lawrence Berkeley Lab.). Feb 1972. Contract W-7405-eng-48. 87p. Dep. NTIS.

Thesis.

An ion-beam scattering cell apparatus was employed to measure product-ion velocity and angular distributions from reactive scattering $O_2^+(C_2D_2,C_2D)O_2D^+$ and inelastic scattering of ArD^+, N_2D^+, H_3O^+, D_3O^+, and NH_4^+ by He and D_2. Study of the dynamics of the reactive scattering $O_2^+ + C_2D_2 \rightarrow O_2D^+ + C_2D$ showed that the most favorable reaction event is abstraction of a deuterium atom by the stripping process. This leads one to predict a threshold for abstraction when the kinetic energy relative to the atom equals the endothermicity. The finding of a threshold, and the forward-peaked sharp angular distribution is consistent with this model. Although very little momentum is imparted to the C_2D radical in such a process, it is left with a substantial amount of internal energy. Inelastic scattering of molecular ions ArD^+, N_2D^+, H_3O^+, D_3O^+, and NH_4^+ by helium and deuterium in the range of 40 to 200 eV primary-ion laboratory energy was investigated. Refined impulse approximation calculations were applied. In the ArD^+—He case no de-excitation process and very little inelasticity were observed. The N_2D^+—He case was found to have about the same efficiency of translational—vibrational energy transfer as NO^+—He scattering. No distinct isotope effect was observed for D_3O^+, H_3O^+ in the translational—vibrational energy transfer with helium. In the NH_4^+—He case, energy loss due to collision was determined from the product contour maps. These data will be useful for future detailed exact calculations. In both ArD^+—D_2 and NH_4^+—D_2 cases, large energy transfer was present. Excitation of D_2 even at small angles was explained as the possibility of some reactive channels. (auth)

34436 (RISO—250, pp 388-94) RESONANCE CHARGE EXCHANGE CROSS SECTION FOR CESIUM MEASURED AROUND 2 eV. Andersen, S. A.; Jensen, V. O.; Michelsen, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The resonance charge exchange cross section for cesium was measured in a Q machine at energies around 2 eV. It was found that $\sigma_{c.e} = 0.6 \times 10^{-13}/cm^2 \pm 20\%$. (auth) (Denmark)

34437 ABSOLUTE MEASUREMENT OF 2S ATOM PRODUCTION BY DISSOCIATIVE EXCITATION OF MOLECULAR DEUTERIUM. Cox, Donald M.; Smith, Stephen J. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., A; 5: No. 6, 2 2428-42(Jun 1972).

The cross section for production of metastable (2S) atoms by the process of dissociative excitation of molecular deuterium by electron impact was measured. The measurement includes the quantitative evaluation of detection efficiency, density, and geometrical factors necessary to establish an absolute scale on a purely experimental basis. The method depends on the application of an rf field at the Lamb-shift frequency (1059 MHz) to quench the metastables at the point of excitation. The radiation induced by the applied field is isotropic so that the absolute cross section depends on a simple solid-angle correction. The cross sections at 23.8 and 39.1 eV are 2.97×10^{-18} and 3.40×10^{-18} cm^2, respectively, with a probable error estimated to be ±14%. The energy dependence of the cross section was also measured from threshold to 500 eV. (auth)

34438 SPIN-CHANGE FREQUENCY SHIFTS IN H–H COLLISIONS. Allison, A. C. (Smithsonian Astrophysical Observatory, Cambridge). Phys. Rev., A; 5: No. 6, 2695-6(Jun 1972).

Accurate calculations of the frequency-shift cross section for collisions of two hydrogen atoms are presented for a range of temperatures. (auth)

34439 COMMENT ON THE SEPARABLE APPROXIMATION FOR INTERMEDIATE-ENERGY ELECTRON–ATOM SCATTERING. Kujawski, E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., A; 5: No. 6, 2690-2(Jun 1972).

The separable approximation for the correlation function proposed by Mittleman is critically examined. It is shown that this assumption is generally inconsistent with the properties of the correlation function and that it is unnecessary for reducing the elastic scattering to a pair of coupled Schrödinger equations. The resulting pair of coupled equations is explicitly given and its validity is investigated. (auth)

34440 VERY-SMALL-ANGLE CHARGE EXCHANGE IN He^+ + He COLLISIONS. Eriksen, F. J.; Fernandez, S. M.; Pollack, E. (Univ. of Connecticut, Storrs). Phys. Rev., A; 5: No. 6, 2443-6(Jun 1972).

The results of earlier charge-exchange measurements in He^+ + He collisions are extended down to scattering angles of 0.05° at energies of 1.00, 2.00, and 3.00 keV. The structure in the probability of charge exchange as a function of angle is clearly demonstrated. At very small angles the incident beam interferes with scattering measurements, and a technique for studying structure in this angular region is described. (auth)

34441 SIMPLIFIED APPROACHES TO REARRANGEMENT PROCESSES AND RESONANCE STATES. Hahn, Yukap (Univ. of Connecticut, Storrs). Phys. Rev., A; 5: No. 6, 2452-7(Jun 1972).

Reactions involving a few open channels with particle rearrangements are treated by a combination of the theory of sequential projections and the quasi-minimum principle. A simple variational procedure of evaluating the resonance energies is proposed, which does not make explicit use of the full open-channel projection operators nor require the exact Green's function in the coupled static approximation. A part of the open-channel problem is also treated variationally using the double functional, so that the resulting scattering parameters are expected to have the quasi-bound property. The positron-hydrogen scattering system above the pickup threshold is studied in detail. (auth)

34442 MINIMA OF GENERALIZED OSCILLATOR STRENGTHS FOR ELECTRON-IMPACT EXCITATION OF THE 6 $^1P_1$ AND 6p' $^3P_1$ STATES OF Hg. Hanne, F.; Kessler, J. (Univ., Muenster, Ger.). Phys. Rev., A; 5: No. 6, 2457-9(Jun 1972).

Differential cross sections for excitation of the 6 $^1P_1$ and 6p' $^3P_1$ states of mercury were measured at angles where minima of the generalized oscillator strengths could be expected. The minima appeared for both channels. Contrary to the results of the first Born approximation, their position depends not only on the momentum transfer but also on the primary energy. The confidence of some authors in the reliability of the Born approximation for inelastic scattering is not justified. (auth)

34443 EIKONAL THEORY OF INELASTIC ELECTRON–ATOM SCATTERING AT INTERMEDIATE ENERGIES. Chen, Joseph C. Y. (Univ. of California, San Diego, La Jolla); Joachain, Charles J.; Watson, Kenneth M. Phys. Rev., A; 5: No. 6, 2460-74(Jun 1972).

An eikonal distorted-wave theory is proposed for inelastic electron–atom collisions at intermediate energies. The primary interaction, responsible for the transition, is treated to first order, and the initial- and final-state interactions are taken into account by using the eikonal approximation. Direct and exchange collisions are both considered. Detailed numerical calculations are performed for the excitation of the n = 2 levels of atomic hydrogen by electron impact. The results for the differential excitation cross sections are compared with those obtained in the Glauber eikonal approximation at small scattering angles. (auth)

34444 BROADENING OF D LINES AND RELAXATION OF RESONANCE LEVELS OF SODIUM DUE TO COLLISIONS WITH HELIUM. Lewis, E. L. (Univ. of Colorado, Boulder. Univ. of Newcastle upon Tyne, Eng.); McNamara, L. F. Phys. Rev., A; 5: No. 6, 2643-51(Jun 1972).

Calculated potentials for the NaHe molecule are used to obtain collision-induced widths and shifts for the sodium D lines together with cross sections for fine-structure transitions and the relaxation of the multipole polarizations of the resonance levels. The atomic collision is treated in an adiabatic approximation in which the colliding atoms form a molecular system that rotates during the collision. The resonance lines are found to be broadened equally and to be approximately 70% wider, and with associated shifts of an order of magnitude smaller, than expected on the basis of van der Waals forces. The dependence of the cross sections for relaxation of the multipole polarizations of the resonance levels on the molecular-coupling conditions and the rotation of the system during collision is discussed and indicates a limitation on the sum rule for these cross sections. Good overall agreement with the existing experimental data is obtained. (auth)

34445 MULTIPLE-SCATTERING EFFECTS IN HIGH-ENERGY ELECTRON–MOLECULE COLLISIONS. I. DIATOMIC MOLECULES. Yates, A. C.; Tenney, A. (Indiana Univ., Bloomington). Phys. Rev., A; 5: No. 6, 2474-81(Jun 1972).

The multiple-scattering theory of Glauber is used to investigate the importance of double scattering in the collisions of fast electrons with diatomic molecules. By representing the atomic potentials as a sum of Yukawa terms, comparisons of scattering amplitudes calculated by the partial-wave analysis and the high-energy approximation (Moliere) are made over a wide range for several atoms. At 40 keV the amplitudes are found to be numerically equivalent to within a few percent, with the agreement worsening with decreasing energy. Calculations for N_2 at 0.5 and 40 keV and for I_2 and U_2 for 40-keV incident electron energies are presented; these results can be regarded as quantitative estimates of the importance of double scattering for a system of two atoms as a function of atomic number. This U_2 calculation is compared with a similar calculation by Hoerni. In contrast to his findings, the double-scattering contribution to the differential cross section is seen to be negative in the small-angle region. In any event, for all cases considered, the multiple-scattering correction is quite small, amounting to no more than ±2% of the differential cross section for any angle of scattering. (auth)

34446 K-SHELL IONIZATION OF CARBON BY FAST PROTONS. Toburen, L. H. (Battelle-Northwest, Richland, Wash.). Phys. Rev., A; 5: No. 6, 2482-7(Jun 1972).

The cross sections for K-shell ionization of carbon were measured for incident protons with energies from 0.3 to 2.0 MeV. These cross sections were obtained from Auger-electron yields measured for methane, ethane, ethylene, and acetylene gas targets assuming that each K-shell vacancy results in the emission of an Auger electron. The molecular surroundings of the carbon atom were found to influence the K-Auger-electron yield; e.g., for 1.0-MeV-proton impact, the carbon-K-shell ionization cross section was 1.00×10^{-18} cm^2 for acetylene and 1.10×10^{-18} cm^2 for ethane. These differences are larger than the estimated uncertainty in the relative values of the measured cross sections (5%). The estimated uncertainty in the absolute value of the cross sections is 20%. A comparison of these Auger-electron yields with published x-ray-production cross sections was used to estimate the fluorescent yield of carbon. The fluorescent yield determined from these data was found to vary with proton energy from 0.0016 at 0.3 MeV to 0.0025 at 2.0 MeV. (auth)

34447 NEW MEASUREMENTS OF EXCITATION TRANSFER IN LOW-DENSITY HELIUM GAS. Krause, Daniel Jr.; Soltysik, Edward A. (Univ. of Massachusetts, Amherst). Phys. Rev., A; 5: No. 6, 2488-95(Jun 1972).

The effect of the transfer of excitation on the population of the 3 ^{3}D state of helium was measured. Through careful diagnosis of a proton beam passing through a long target chamber containing helium gas, the various contributions to the light intensity from the 3 ^{3}D state were separated. These measurements were performed at target-gas pressures roughly two orders of magnitude lower than those of previously reported measurements. The summation of the excitation-transfer cross sections $\sigma_c(n)$ for the transfer from an n ^{1}P state to the corresponding n ^{3}F state times the branching ratio B_n for radiative cascade to the 3 ^{3}D state was measured, and found to be $\Sigma B_n \sigma_c(n) = 2.2 \times 10^{-12}$ cm^2. This measurement makes it possible to relate the excitation transferred to the 3 ^{3}D state $Q_T(3\ ^3D)$ to the excitation cross section of the 4 ^{1}P state $\sigma(4\ ^1P)$. The expression $Q_T(3\ ^3D) = (1.5 \times 10^{-15}\ \mathrm{cm}^3)\ N\ \sigma(4\ ^1P)$, which, for the low pressures used in this experiment, is linear in the number density N, was obtained. (auth)

34448 DISSOCIATIVE RECOMBINATION OF ELECTRONS WITH He_2^+. Johnson, A. Wayne; Gerardo, J. B. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett.; 28: No. 17, 1096-8 (24 Apr 1972).

Experimental results are reported, which conclusively show that diatomic molecular helium ions recombine dissociatively with electrons. It is shown that dissociative recombination accounts for at least half of the total electronic recombination of He_2^+ at a temperature of 300°K and in the pressure range from 15 to 55 torr. The experimental technique used includes measurement of the perturbation of the 2^3S metastable density that results from a time-dependent perturbation of the electronic recombination coefficient. (auth)

34449 GENERALIZED PSEUDOPOTENTIAL APPROACH FOR ELECTRON–ATOM SCATTERING. Zarlingo, Donald G.; Ishihara, T.; Poe, Robert T. (Univ. of California, Riverside). Phys. Rev. Lett.; 28: No. 17, 1093-5(24 Apr 1972).

A generalized many-electron pseudopotential approach is presented for electron–neutral-atom scattering problems. A calculation based on this formulation is carried out for the singlet s-wave and p-wave electron–hydrogen phase shifts with excellent results. The method is compared with other approaches and its applications for inelastic and rearrangement collision problems are discussed. (auth)

34450 HYDROGEN–ANTIHYDROGEN INTERACTIONS. Junker, B. R.; Bardsley, J. N. (Univ. of Pittsburgh). Phys. Rev. Lett.; 28: No. 19, 1227-9(8 May 1972).

The interaction potential between hydrogen and antihydrogen is obtained by a variational calculation. A potential maximum is found, but its peak is below the dissociation limit. A classical calculation shows that the cross section for total annihilation decreases monotonically from $31a_0^2$ at 0.01 eV to $4a_0^2$ at 20 eV. (auth)

34451 UNIVERSAL FUNCTION FOR IONIZATION OF ATOMS, IONS, AND MOLECULES BY STRUCTURELESS CHARGED PARTICLES OF ARBITRARY MASS AND CHARGE. Bely, O.; Faucher, P. (Observatoire, Nice). Astron. Astrophys.; 18: No. 3, 487-92(May 1972).

Using classical impulse approximation and experimental results, a semi-empirical expression obtained for the ionization cross section of an arbitrary target by structureless particles of given mass and charge. The method is discussed and compared with various experiments. The range of its validity is given. (auth)

34452 MEASUREMENT OF DIFFERENTIAL CROSS SECTIONS OF LOW-ENERGY ELECTRONS ELASTICALLY SCATTERED BY GAS MOLECULES. I. APPARATUS. Kambara, Hideki; Kuchitsu, Kozo (Tokyo Univ.). Jap. J. Appl. Phys.; 11: No. 5, 609-16(May 1972).

An electron diffractometer designed for the study of elastic scattering of a low-energy electron beam by a flow of gas molecules emitted from a fine nozzle was constructed. As a check of the accuracy of the measurement, relative differential cross sections for the nitrogen molecule were measured with an angular precision and resolution of about 0.3° and less than 1°, respectively. The angular distributions of the scattered electrons, measured from 4° to 150°, agree within 50% (in the relative scale) with those measured by Bromberg in the range from 5° to 110° at incident electron energies of 300 eV and 500 eV in spite of the differences in the techniques. Similar measurements made for 100- and 50-eV electrons show minimum cross sections at about 90°. (auth)

34453 ELECTRONIC STATES OF H_2O^+ PRODUCED BY ELECTRON BOMBARDMENT OF H_2O. Lindemann, Ellen; Rozett, R. W.; Koski, W. S. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 56: No. 11, 5490-2(1 Jun 1972).

The abundances of the electronic states of H_2O^+ produced by electron bombardment of H_2O vapor in the energy range 12 to 70 eV were determined by studying the attenuation of the H_2O^+ ion beam in nitrous oxide. The ground state ($^2B_1$), the first excited state ($^2A_1$), and probably the second excited state ($^2B_2$) were found to be present, and the abundance of each was found to be a function of the electron bombarding energy and the water vapor pressure in the ion source. (auth)

34454 HIGH ENERGY-RESOLUTION STUDIES OF ELECTRON-IMPACT OPTICAL EXCITATION FUNCTIONS. I. THE SECOND POSITIVE SYSTEM OF N_2. Finn, T. G.; Aarts, J. F. M.; Doering, J. P. (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 56: No. 11, 5632-6(1 Jun 1972).

The relative emission cross section for the N_2 second positive system (0,0) and (1,0) bands excited by electron impact was measured for incident electron energies from threshold to 17 eV. By using a high-energy-resolution electron spectrometer coupled to an optical detection system, it was possible to perform the measurements with an incident electron beam having an energy half width of 50 meV (fwhm). Observation of various scattering resonances in nitrogen and helium provided an accurate calibration of the incident electron energy. The maximum of the N_2 second positive system (0,0) band emission cross section (λ3371 Å) was found to be at 14.02 ± 0.05 eV. The maximum for the (1,0) second positive band (λ3159 Å) was found to be at 14.3 ± 0.1 eV. Two small structural features corresponding to the onset of additional channels for population of the N_2 $C^3\Pi_u$ state were observed at 11.48 eV and between 11.8 and 12.3 eV. The first feature was pressure-independent and appeared only in the (0,0) band emission cross section. This feature apparently arises as a consequence of decay of the compound state responsible for the 11.48-eV N_2 elastic scattering resonance to the N_2 $C^3\Pi_u(\nu' = 0)$ state. The second feature was broad and pressure-dependent. It appeared more strongly in the (1,0) band cross section than in that for the (0,0) band. Collisional quenching of the N_2 $E^3\Sigma_g^+$ state via a collision-induced crossing into the vibrational states of the N_2 $C^3\Pi_u$ state appears to be the best explanation of this effect. (auth)

34455 MULTIPOLE–MULTIPOLE QUENCHING CROSS SECTION FOR COLLISION BETWEEN EXCITED ATOMS AND MOLECULES. Chiu, Ying-nan (Catholic Univ. of America, Washington, D. C.). J. Chem. Phys.; 56: No. 11, 5741-2(1 Jun 1972).

The total cross section for quenching in collisions between excited atoms and diatomic molecules is obtained by generalizing previously derived differential and total cross sections for the collision between two diatomic molecules. An expression for the reduced multipole matrix element for an atomic transition is given and related to the lifetime and to Einstein's coefficient for spontaneous (multipole) emission of the atomic state. (A.G.W.)

34456 ANALYTIC CONTINUATION OF CLASSICAL MECHANICS FOR CLASSICALLY FORBIDDEN COLLISION PROCESSES. Miller, William H.; George, Thomas F. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 11, 5668-81 (1 Jun 1972).

Classically forbidden processes are those that cannot take place via ordinary classical dynamics. Within the framework of classical S-matrix theory, however, classical mechanics can be analytically continued and classical-limit approximations obtained for these classically forbidden or weak transition amplitudes (i.e., S-matrix elements). The most powerful and general way of analytically continuing classical mechanics for a complex dynamical system is to integrate the equations of motion themselves through the classically inaccessible regions of phase space. Success in calculating these analytically continued trajectories is reported in this work; with certain special features of these complex-valued trajectories recognized and taken account of, it is seen that they are essentially as easy to deal with numerically as ordinary (i.e., real) classical trajectories. Application to the linear A + BC collision (vibrational excitation) gives excellent results; transition probabilities as small as 10^{-11} (the smallest ones available for comparison) were obtained, agreement with the exact quantum mechanical values being within a few percent. (auth)

34457 SEMICLASSICAL THEORY OF ELECTRONIC TRANSITIONS IN LOW-ENERGY ATOMIC AND MOLECULAR COLLISIONS INVOLVING SEVERAL NUCLEAR DEGREES OF FREEDOM. Miller, William H.; George, Thomas F. (Univ. of California, Berkeley). J. Chem. Phys.; 56: No. 11, 5637-52(1 Jun 1972).

A semiclassical theory is developed for describing electronic transitions in low-energy atomic and molecular collisions, such as A + BC, that involve quantized nuclear degrees of freedom (i.e., rotation and vibration) as well as translation. The principal physical idea is that in this low-energy regime the dynamics is essentially classical motion of the nuclei on electronically adiabatic potential-energy surfaces, with transitions between surfaces being events that are localized in space and time. The quantum principle of superposition is incorporated in the formulation in that classical dynamics is used to construct the classical limit of amplitudes (i.e., S-matrix elements) for transitions from a specific initial electronic–rotational–vibrational state of A + BC to a specific final electron–rotational–vibrational state of A + BC or AB + C, etc. Approximate and "exact" versions of the theory are developed, and in the "exact" version it is seen clearly that electronic transitions are inherently a "classically forbidden" process in that the classical action along the trajectories appropriate for such transitions has an imaginary contribution. (auth)

34458 STUDY OF THE A → X TRANSITIONS IN N_2^+ AND CO^+. Holland, Redus, F.; Maier II, William B. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 56: No. 11, 5229-46(1 Jun 1972).

Optical emissions from long-lived, excited states of CO^+ and N_2^+ in ion beams were studied. CO or N_2 was ionized by electron impact, and the ions were removed from the ion source to the observation region. Spectra of emission from CO^+ and N_2^+ were obtained for wavelengths in the ranges 3200 to 5200 Å and 6000 to 8700 Å, respectively. All of the spectral features can be ascribed to the CO^+ comet-tail and N_2^+ Meinel emission systems. The electronic transition moments, $\overline{R}_e$, for these two emission systems are determined and are found to vary rather slowly with wavelength over the wavelength ranges for which data were obtained. Lifetimes of the $\nu' = 1, 2, 4$, and 6 vibrational levels of CO^+ (A $^2\pi$) are found to be 3.49, 2.78, 2.63, and 2.41 μs, respectively. Lifetimes of the $\nu' = 2, 3, 4$, and 5 vibrational levels of N_2^+ (A $^2\pi_u$) are found to be 12.28, 10.70, 10.08, and 9.14 μs, respectively. The dependences of the measured lifetimes on ν' are consistent with the experimental values of R_e and with available Franck–Condon factors. Relative cross sections for excitation of various emission bands were derived from the spectra and lifetimes presented; these cross sections agree fairly well with theory and with previous measurements. The A states of CO^+ and N_2^+ appear to constitute about 46% and 30%, respectively, of the ions produced by 46.5-eV electrons impinging on CO and N_2. The electron-energy dependences of the light output in the (2,0) Meinel band and in the (3,0) and (4,0) comet-tail bands were measured from threshold to 200 eV. From the data and total ionization cross sections, maximum cross sections for excitation of the (2,0) Meinel and the (3,0) comet-tail bands of 0.073 and 0.133 Å², respectively, were obtained. (auth)

34459 EXPERIMENTAL DETERMINATION OF THE REPULSIVE POTENTIALS BETWEEN K^+ IONS AND RARE GAS ATOMS. Inouye, H.; Kita, S. (Tohoku Univ., Sendai). J. Chem. Phys.; 56: No. 10, 4877-82(15 May 1972).

Integral elastic scattering cross sections were measured by the attenuation method for potassium ions with an energy selected in the range of 500 to 4000 eV scattered by room-temperature He, Ne, Ar, and Kr atoms through effective laboratory angles greater than 5×10^{-3} radian. The repulsive potentials were derived from the measured values of the cross sections with allowance for the density distribution across the beam in the collision chamber. The potentials are well represented by the following expressions: for He, $V(r) = 1110 \exp(-4.15r)$ for $1.23 < r < 1.77$; for Ne, $V(r) = 4910 \exp(-4.40r)$ for $1.55 < r < 2.04$; for Ar, $V(r) = 2920 \exp(3.46r)$ for $1.79 < r < 2.43$; and for Kr, $V(r) = 6420 \exp(-3.69r)$ for $1.92 < r < 2.53$. V(r) is in electron volts and r in angstroms. (auth)

34460 THEORETICAL STUDIES OF $H + H_2$ ROTATIONALLY INELASTIC SCATTERING. Wolken, George Jr.; Miller, William H.; Karplus, Martin (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 56: No. 10, 4930-46(15 May 1972).

Rotationally inelastic $H-H_2$ scattering, without rearrangement, was studied quantum mechanically in three dimensions. A close-coupling technique was employed with a basis set consisting of unperturbed molecular functions. The resulting coupled differential equations were solved numerically by a technique recently developed by Gordon. The Porter–Karplus semi-empirical potential surface was used to represent the H_3 system. Cross sections were calculated for relative kinetic energies of 0.05 to 0.50 eV. Various approximations were investigated and their effect on the inelastic cross sections was computed; they include variation of the number of terms in the expansion of the exact wave function, exclusion of high-order asymmetry contributions to the potential surface, treating the H_2 target as a rigid rotor fixed at some specified internuclear distance, and modifying the long-range behavior of the Porter–Karplus surface. Differential cross sections in the helicity representation were also computed for various energies. (auth)

34461 SEMICLASSICAL THEORY OF WEAK VIBRATIONAL EXCITATION. Pechukas, Philip; Davis, Jon P. (Columbia Univ., New York). J. Chem. Phys.; 56: No. 10, 4970-5(15 May 1972).

A semiclassical theory of vibrational excitation in low-energy collisions is discussed for the case that the interaction depends only weakly on vibrational coordinate and the process is strongly forbidden, classically, in the sense of Miller and Marcus. It is argued that this may be the interesting case for purposes of extracting information from differential cross sections on the vibrational coordinate dependence of intermolecular potentials. (auth)

34462 DISTORTED-WAVE CALCULATION OF VIBRATIONAL EXCITATION AND TRANSFER IN H_2 AND D_2. Calvert, J. B. (Univ. of Denver). J. Chem. Phys.; 56: No. 10, 5071-74(15 May 1972).

A numerical three-dimensional distorted-wave calculation has been made for V–T and V–V vibrational excitation cross sections in H_2, D_2, and their mixtures, for energies within 1.5 eV of threshold. The corresponding relaxation times were calculated for temperatures between 300 and 1000°K and the results are compared with shock-tube and stimulated Raman emission data. (auth)

34463 ERRATUM: THEORY OF INELASTIC COLLISIONS: UNIFORM ASYMPTOTIC (WKB) SOLUTIONS AND SEMICLASSICAL S-MATRIX ELEMENTS FOR TWO-CHANNEL PROBLEMS. Eu, Byung Chan (McGill Univ., Montreal). J. Chem. Phys.; 56: No. 10, 5202-3(15 May 1972).

Two pages of the original article of the above title (J. Chem. Phys., 55: 5600-09 (1971)) are reprinted to correct a serious notational error in the setting of the script A's. (A.G.W.)

34464 MODEL POTENTIAL FOR VIBRATIONAL EXCITATION OF DIATOMIC MOLECULES. White, R. A.; Hayes, E. F. (Rice Univ., Houston, Tex.). Chem. Phys. Lett.; 14: No. 1, 98-102(1 May 1972).

A model interaction potential for the vibrational excitation of H_2 by Li^+ of the form $C \exp(-\alpha x + \beta y)$ is studied using noniterative integral techniques. The results show that vibrational excitation is sensitive to small quantitative change in qualitatively similar surfaces. (auth)

34465 APPROXIMATIONS FOR COLLISIONAL AND RADIATIVE TRANSITION RATES IN ATOMIC HYDROGEN. Johnson, L. C. (Princeton Univ., N. J.). Astrophys. J.; 174: No. 1, 227-36(15 May 1972).

A simple, accurate, and complete set of approximate formulas is presented for evaluating collisional and radiative transition rates for bound–bound and bound–free transitions in atomic hydrogen. The approximations are chosen in a form that facilitates computer programming and solution of nonequilibrium excitation problems of interest in plasma physics and astrophysics. Detailed comparisons are made with experimental, theoretical, and other semiempirical results. (auth)

34466 SEMIEMPIRICAL CALCULATIONS FOR ELECTRON-IMPACT EXCITATION OF THE HYDROGEN ATOM. Felden, Madeleine M.; Felden, Marceau A. (Laboratoire de Physique des Milieux Ionises, Nancy). Astrophys. J.; 174: No. 1, 219-26(15 May 1972).

Cross sections for electron-impact excitation are calculated for the hydrogen atom using the wave function $\psi_0(r_1, r_2) = \phi_0(r_1) g(r_1, r_2)$. A screening numerical factor is introduced into the nuclear charge in order to take into account the term neglected $\nabla_1 \ln \phi_0(r_1) (\nabla_R \ln g - \nabla_\rho \ln g)$. A modification of the hypothesis introduced by Vainshtein et al. for the matrix element calculation is proposed. The results relative to transitions 1s → 2s, 1s → 2p, and ionization are in fair agreement with the experimental values. Cross sections relative to some transitions that are experimentally unknown are calculated. (auth)

34467 MEASUREMENT OF THE DIFFERENTIAL CROSS SECTION FOR H(n equals 2) DIRECT EXCITATION IN H^+-ON-H COLLISIONS. Houver, J. Ch.; Fayeton, J.; Abignoli, M.; Barat, M. (Univ. Paris, Orsay, France). Phys. Rev. Lett.; 28: No. 22, 1433-5(29 May 1972).

Experimental differential cross sections for elastic scattering and the n = 2 excitation in H^+-on-H collisions at an impact energy of 1 keV were measured, and the results are compared with previous theoretical calculations. (auth)

34468 ELECTRON LOSS CROSS SECTIONS FOR FAST He–He COLLISIONS. Goldberg, Fred Marvin. Ann Arbor, Mich.; Univ. of Michigan (1971). 132p. University Microfilms Order No. 72-14,876.

Thesis.

The electron-loss cross sections for He metastable (triplet and singlet) atoms and He ground-state atoms in He were measured in the energy range 2 to 5.5 keV with an atomic beams apparatus. Since the metastable and ground-state electron-loss cross sections are considerably different, it is necessary to determine the beam composition in order to correctly interpret the observed cross sections. A fast He^+ beam was partially neutralized in either K vapor or He gas, and, after the remaining ions were deflected away, the fast neutral beam entered a thin He stripping target. The apparent electron-loss cross section, σ_L^{App}, was determined from the dependence of the resulting fast ion current on the target density. This experiment was different from previous measurements of the loss cross sections at this energy in that σ_L^{App} was measured for two neutralizers where the corresponding values of f_x were estimated to within reasonable confidence limits. The absolute values of σ_L^M and σ_L^G, cross sections for the metastable and ground states, could then be separately determined. For a He neutralizer, where the capture into the ground state represents a symmetric resonant process, the value of f_{He} is assumed to be small. Analyzing the results of related experiments it was estimated $f_{He} = 0.014 \pm 0.008$. For a K neutralizer, capture into one of the n = 2 levels of He is nearly resonant ($\Delta E < 1$ eV), implying a large fraction of metastables. Arguments based on statistical weights and using the results of a measurement of the secondary emission coefficient (which is very sensitive to the fraction of metastables) give $f_K = 0.88 \pm 0.12$. In the energy range 2 to 5.5 keV, σ_L^M was found to be 10 to 40 times larger than σ_L^G, the ratio increasing with decreasing impact energy. The fractions of metastables formed in thin H_2, Ar, and N_2 neutralizers were also determined. Significant errors were introduced, however, due to the small-angle scattering that accompanied the charge transfer. In the case of the H_2 neutralizer, the measured value for the metastable fraction was considerably larger than would be expected from other measurements at higher energies. (Diss. Abstr. Int., B)

34469 INTERNATIONAL COLLOQUIUM ON SIMPLE AND MULTIPLE ELECTRONIC PROCESSES IN THE X AND XUV REGION, PARIS, SEPTEMBER 21-25, 1970. J. Phys. (Paris), Colloq.; No. 4, 1-344(1971). (In French and English). (CONF-700979).

Sixty-three papers were presented, and they are grouped in two sections. The first section deals with mechanisms of primary ionization by photons and electrons, processes of rearrangement of ionized atoms, and multiply ionized atomic states. Electron processes in solids, the x-ray spectroscopic studies of band structures and the electron microscopy are presented in the second section. A separate abstract is included for each of the 13 papers in scope. (France)

For abstracts of individual papers see: 34267, 34407, 34470–34473, 34485, 34984, 35081–35083, 35217, and 35218.

34470 SYSTEMATICS OF ELECTRON, PROTON, AND PHOTON IONIZATION CROSS SECTIONS. McGuire, E. J. (Sandia Labs., Albuquerque, N. Mex.). J. Phys. (Paris), Colloq.; No. 4, 37-9(1971).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

Results concerning cross section calculations using a one-electron unrelaxed core model to compute generalized oscillator strengths are presented. It is found that the electron and proton ionization cross sections can be expressed in a reduced and possibly universal form. The possibility of expressing photoionization cross sections in a reduced form is then discussed. (France)

34471 ABSOLUTE ELECTRON IMPACT IONIZATION CROSS SECTIONS OF N, O, and Ne. Glupe, G.; Mehlhorn, W. (Univ., Muenster, Ger.). J. Phys. (Paris), Colloq.; No. 4, 40-3(1971).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

The relative and absolute electron-impact ionization cross sections of the K shell of N, O, and Ne were measured from Auger electron transition observations made for electron energies ranging from E = 1.5 to 10.5 keV (in the case of N and Ne) and 13 keV (in the case of O). Gaseous targets were used for all of the experiments. The experimental results are compared with theoretical values calculated by Burhap, and Rudge and Schwartz (quantum theory) and by Gryzinski (classical theory). (France)

34472 SIMPLE AND MULTIPLE IONIZATION MECHANISMS RESULTING FROM ELECTRON IMPACT WITH CERTAIN ME-

TALLIC VAPORS. Abouaf, R. (Univ., Paris). J. Phys. (Paris), Colloq.; No. 4, 128-31(1971). (In French).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

It is shown that numerous slope discontinuities in the ionization curves of multicharged atomic ions may be attributed to the simple Auger effect (Sr^{2+}, Ba^{2+}, Mn^{2+}, Mn^{4+}). However in the case of highly charged ions (Mn^{5+}, Mn^{6+}, Cd^{5+}, Cd^{6+}, and certain In and Ag ions) supplementary shake-off processes may occur during primary ionization (multiple primary ionization: Cd^{5+}, In^{5+}, Ag^{5+}) or during the Auger cascade (multiple Auger transition In^{7+}, Ag^{7+}). (France)

34473 MANIFESTATION OF ATOMIC DYNAMICS THROUGH THE AUGER EFFECT. Krause, M. O.; Carlson, T. A.; Moddeman, W. E. (Oak Ridge National Lab., Tenn.). J. Phys. (Paris), Colloq.; No. 4, 139-44(1971).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

Auger spectra are shown to yield detailed information on the interaction of radiation or particles with atomic electrons and on the mechanics of electron–electron interaction with the inner-shell-ionized atom. Processes such as simple ionization, simple excitation, double ionization, excitation–ionization, etc. can be distinguished and studied by Auger spectrometry. Ninety of the Ne spectral lines are classified in terms of these fundamental processes. The relative energies and intensities of the lines associated with different fundamental processes are presented; comparisons are made with theoretical predictions and other experimental results. The dependence of the spectra on the mode of excitation is discussed. (France)

Atomic Theory

Refer also to abstract 34586.

34474 CONFIGURATION-SPACE HAMILTONIAN FOR HEAVY ATOMS AND CORRECTION TO THE BREIT INTERACTION. Mittleman, Marvin H. (City Coll., New York). Phys. Rev., A; 5: No. 6, 2395-2401(Jun 1972).

The lowest-order configuration-space Hamiltonian (CSH) for a heavy atom is constructed from quantum electrodynamics by a variational procedure. A variational potential function Ω is introduced, which in effect allows some freedom in the choice of the definition of the difference between electrons and positrons. The optimization of Ω results in a nonlinear equation from which it is shown that Ω is probably not small for relativistic electrons. The procedure results in a CSH that contains a new two-body interaction which is relativistic in origin and which is apparently of the same order of magnitude as the Breit interaction when acting between relativistic electrons. (auth)

34475 UPPER AND LOWER BOUNDS TO THE EIGENVALUES OF TWO-ELECTRON ATOMS: PROOF THAT THE $2\ ^1\ ^3S$ STATES OF H^- ARE NOT BOUND. Power, J. D.; Somorjai, R. L. (National Research Council of Canada, Ottawa). Phys. Rev., A; 5: No. 6, 2401-3(Jun 1972).

A new type of expansion is proposed for obtaining accurate wave functions for $^{1,3}S$ states of two-electron atoms, expressing Ψ as a sum of "configurations" of the form $(1 \pm P_{12}) \exp(-\alpha_i r_1 - \beta_i r_2 - \gamma_i r_{12})$. Matrix elements of both H and ^2H can be easily evaluated for these configurations. Results of an illustrative calculation of the $2\ ^{1,3}S$ states of H^-, which proves them to be unbound, are given. (auth)

34476 SOLUTION OF THE DIRAC EQUATION FOR STRONG EXTERNAL FIELDS. Mueller, Berndt; Peitz, Heinrich; Rafelski, Johann; Greiner, Walter (Univ., Frankfurt am Main). Phys. Rev. Lett.; 28: No. 19, 1235-8(8 May 1972).

The 1s bound state of superheavy atoms and molecules reaches a binding energy of $-2mc^2$ at $Z \approx 169$. It is shown that the K shell is still localized in r space even beyond this critical proton number and that it has a width Γ (several keV large), which is a positron escape width for ionized K shells. The suggestion is made that this effect can be observed in the collision of very heavy ions (superheavy molecules) during the collision. (auth)

34477 ROLE OF ATOM–FIELD CORRELATIONS IN COHERENT INTERACTIONS. Knight, P. L.; Allen, L. (Univ. of Sussex, Brighton, Eng.). Phys. Lett.; 39A: No. 3, 237-9(8 May 1972).

The nature of the semiclassical approximation used in the theory of the coherent interactions between fields and two-level atoms is discussed, and the role of atom–field correlations is examined. (auth)

34478 MODEL HAMILTONIAN FOR THE PERIODIC TABLE. Novaro. Octavio A.; Wolf, Kurt Bernardo (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis.; 20: No. 4, 265-8(1971).

In order to predict the building-up of the many-electron atomic ground states, a model Hamiltonian having one adjustable parameter related to the asymmetric point rotor in Fock's projected momentum space is proposed. With the exception of the 5d level, the correct ordering is achieved. (auth)

34479 PROPERTY-OPTIMIZED GAUSSIAN ATOMIC ORBITALS. Page, Gerald; Ludwig, Oliver G. (Villanova Univ., Pa.). J. Chem. Phys.; 56: No. 11, 5626-31(1 Jun 1972).

Property-optimized Gaussian expansions of 1s-, 2s-, and 2p-Slater-type orbitals are obtained by weighting the usual fittings with r^{-2}, r^{-1}, r, and r^2. Pseudonormalized expectation values of r^{-2}, r^{-1}, r, r^2, and $-\frac{1}{2}\nabla^2$ calculated with the very small-term expansions are of exceptional quality by comparison with the values calculated with unweighted expansions. (auth)

34480 REDUCED PARTITIONING PROCEDURE IN CONFIGURATION-INTERACTION STUDIES. I. GROUND STATES. Bartlett, Rodney J.; Braendas, Erkki J. (Univ. of Florida, Gainesville). J. Chem. Phys.; 56: No. 11, 5467-77(1 Jun 1972).

A variation–perturbation approach to configuration-interaction (CI) studies of atoms and molecules was derived, which yields a series of converging upper bounds to the CI energy. As a consequence, the method permits an adequate representation of a large n-particle wave function in terms of a very low-order nonlinear perturbation summation. This "reduction" procedure is found to have simplifications for full CI studies as well as suggesting certain systematic improvements over the standard Hartree–Fock (HF) and "truncated" CI calculations. The first-order solution, which is equivalent to the application of a geometric sum rule to the perturbation expansion, is also shown to be derivable from a "steepest descent" argument. In preliminary calculations on H_2 and the HeH^+ molecular ion with a HF function as the unperturbed state, the first-order result gives 60% to 70% of the energy difference between the full CI energy and the HF value, while only a third-order treatment accounts for better than 90%. Potential curves for the ground state of HeH^+ for the eight lowest orders of solution and their spectroscopic parameters are also obtained, with the eighth-order energies differing from the full CI values by less than 10^{-4} au at all internuclear separations. (auth)

34481 SPIN -½ FORMALISM FOR TWO-LEVEL PROBLEMS. Venkatesh, H. G.; Dixit, L. P. (Birla Inst. of Tech., Mesra, India). Indian J. Phys.; 44: No. 9, 475-87(Sep 1970).

The formalism of the theory of angular momentum (spin-½) is the most appropriate for the treatment of the two-level problem (interaction of radiation with a quantum mechanical system with an isolated pair of eigenstates of energy). The density matrix and the total Hamiltonian can be expressed as vectors in a coordinate system spanned by the basic spin representations related to spin space. The dynamical problem is solved by finding from the equation of motion the spinor transformation T, which effects the rotation of the density operator. The spin-½ formalism shows the interconnections among the distinctive methods of treating the problem (Feynman & Vernon 1957, Dicke 1954, and Lamb 1964). An analytic solution of the mechanical problem of finding the polarization for the transition $\Delta m = 0$ is presented. Expressions given for electrical field, power, and oscillation frequency in terms of the one variable, the pulse strength θ_N determined by the density N of molecules interacting with the radiation field in a stationary process. The matrix of interaction containing this parameter is a rotation about the 1 axis in spin space through the pulse angle θ; it operates on the initial system vector to produce the system vector at time t. The latter is a matrix whose elements are the expectation values of the unperturbed Hamiltonian and polarization. (auth)

34482 MULTICONFIGURATION APPROXIMATION FOR THE ns^2 SHELLS OF ATOMS. Kantserjavichyus, A. Yu. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; 11: No. 3, 401-10(1971). (In Russian).

The multiconfiguration approximation $ns^2 + \Sigma nl^2$ for the outer shells of He, Be, and Mg atoms and for the $1s^2$ and $2s^2$ shells of the atoms in configurations $1s^2 2s^2 p^N$ was applied. In the case of the two-configuration approximation $1s^2 2s^2 2p^N + 1s^2 2p^{N+2}$ ($N = 0$, 1, 2, 3, 4) the behavior of the energy contribution ΔE with respect to N, Z, and radial orbitals of correcting configurations was considered. Hartree–Fock analytical radial orbitals were used for the ground configurations and hydrogen-like ones for the correcting configurations. (auth)

34483 EXCHANGE AND CORRELATION POTENTIALS FOR K-SHELL ELECTRONS. Larsson, S.; Calais, J.-L. (Uppsala Univ.). Chem. Phys. Lett.; 14: No. 1, 12-18(1 May 1972).

Commonly used correlation and exchange potentials are examined in the region close to the nucleus and compared to the actual potentials. The $\rho^{1/3}$ exchange potential is found to have an essentially correct behavior for $Z \rightarrow \infty$. The correlation potentials derived from the electron gas show an incorrect behavior near the nucleus. A modification of the Liberman exchange potential is suggested. (auth)

34484 COULOMB APPROXIMATION FOR ANALYTIC MULTIPOLE POLARIZABILITIES OF GROUND- AND EXCITED-STATE ATOMS. Adelman, S. A.; Szabo, Attila (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 28: No. 22, 1427-30(29 May 1972).

An analytic expression for the 2^l-pole static electric polarizability α_l of an atom is obtained in a Coulomb-like approximation. Core effects are neglected and, for simplicity, only s-type valence electrons are considered. Accurate values are obtained for the dipole and quadrupole polarizabilities of the alkali metal atoms and of four alkali-like excited states. Values close to those obtained from coupled Hartree—Fock calculations are computed for several divalent systems. (auth)

34485 REARRANGEMENT OF INNER SHELL IONIZED ATOMS. Krause, M. O. (Oak Ridge National Lab., Tenn.). J. Phys. (Paris), Colloq.; No. 4, 67-75(1971).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

The various processes by which orbital electrons of inner-shell-ionized atoms rearrange are discussed on the basis of experimental evidence and theoretical concepts. In the electronic rearrangement concomitant to the initial ionization event, the shake-off process is recognized as playing a predominant role in multiple excitation of the atom by the incident ionizing photon or particle. Shake-off events are shown to be the direct cause of the occurrence of satellites in x-ray and Auger spectra in both primary and secondary excitation. Relative transition rates of multiple processes are given as a function of the energy of the incident photon or electron, the quantum number of the orbital electron, and the atomic number. Attention is drawn to the importance of electron—electron correlation for the cases where the electrons involved come from the same shell. Rearrangement of the atom following initial single or multiple ionization is discussed in terms of a vacancy cascade in which a series of radiative and Auger transitions take place leading ultimately to an ionic charge distribution, or to violent coulombian fragmentation in the case of molecules. Reference is also made to the double Auger process and to the radiative Auger process. (France)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

Refer also to abstract 33260.

34486 (JUL–802-TP) APPLIED MAGNETOHYDRODYNAMICS. VOLUME 8. CHARACTERISTIC ANALYSES OF THE ELECTRON GAS EQUATION IN NONEQUILIBRIUM MAGNETOHYDRODYNAMICS. Kolb, Gerhard (Kernforschungsanlage, Juelich (West Germany). Institut fuer Technische Physik). Oct 1971. 44p. (In German). Dep. NTIS (U. S. Sales Only).

Characteristics of the general nonstationary electron gas equation of a noble gas–alkali-plasma were studied in the pressure and temperature ranges applicable to MHD energy conversion. The equations appear as a system of elliptical, hyperbolic, and parabolic equations. Many conceivable mathematical simplifications used in the numerical treatment of 2-dimensional approximations are analyzed, and their properties are compared with the generalized system. Most significant is the problem to formulate boundary and initial conditions for the hyperbolic equations in such a way that solutions in the total range of definition become determined. (tr-auth)

34487 STABILITY OF NONROTATIONALLY SYMMETRIC DISTURBANCES FOR INVISCID FLOW BETWEEN ROTATING CYLINDERS IN THE PRESENCE OF A CIRCULAR MAGNETIC FIELD. Pathak, R. S.; Pathak, Lakshman (Banaras Hindu Univ., India). Indian J. Phys.; 45: No. 2, 49-58(Feb 1971).

The stability of an inviscid fluid between two concentric co-rotating cylinders in the presence of a circular magnetic field to nonrotationally symmetric disturbances is investigated in the case when the gap between the two concentric cylinders is small compared to their mean radii. The growth rate of unstable disturbances has been examined for co-rotating cylinders. (auth)

34488 STABILITY OF NONROTATIONALLY SYMMETRIC DISTURBANCES FOR INVISCID FLOW BETWEEN ROTATING CYLINDERS IN THE PRESENCE OF AN AXIAL AND A TRANSVERSE MAGNETIC FIELD. Pathak, R. S.; Pathak, Lakshman (Banaras Hindu Univ., India). Indian J. Phys.; 45: No. 2, 63-73(Feb 1971).

The stability of an inviscid fluid between two coaxial rotating cylinders in the presence of an axial and a transverse magnetic field to nonrotationally symmetric disturbances is investigated under the small-gap approximations. The growth rate of amplified disturbances has been obtained for co-rotating cylinders. The stability criterions for both the co-rotating and counter-rotating cases have been established. (auth)

34489 STUDY OF SOME LOW-SPEED MAGNETOHYDRODYNAMIC FLOWS OF AN ELECTRICALLY CONDUCTING FLUID IN A SPHERICAL CONTAINER. Vacca, J. Atti Seminar. Mat. Fis. Univ. Modena; 18: No. 2, 282-94(1969). (In Italian).

The linearized equations of the flow in a spherical container of an incompressible, inviscid, infinitely conducting fluid in presence of a uniform magnetic field and a potential nonelectromagnetic force are considered. Putting the velocity $v = \text{grad}\ \Phi + \text{rot}\ u$, the harmonic function Φ is the solution of a Neumann problem. This problem is attacked for a sinusoidal-in-time and axially symmetric motion, i.e., with $u = e^{i\nu t} U(r, \theta)\ a_\phi$ (r, θ, ϕ are spherical coordinates and a_ϕ is transversal unit vector), $\Phi = e^{i\nu t}\psi(r, \theta)$. When particularly $U(r, \theta) = U_0 r \sin\theta \cos(\nu/a\ r \cos\theta)$, where a is the Alfvén velocity and U_0 is constant, all unknown quantities are calculated with an infinite series of Legendre polynomials that contain Bessel functions of the first kind. (App. Mech. Rev.)

34490 HYDROMAGNETIC SOURCE FLOW. Khan, M. A. A.; Srivastava, R. B. (Lucknow Univ., India). Indian J. Phys.; 44: No. 12, 647-56(Dec 1970).

The steady flow of a viscous incompressible and electrically conducting fluid between two parallel coaxial rotating disks with a transverse magnetic field is analyzed when the two disks are rotating with the same velocity and there is a source at the center. The velocity of the fluid relative to the disks is supposed to be small. (auth)

34491 CLEBSCH TRANSFORMATION AND RELATIVISTIC MAGNETOHYDRODYNAMICS. Maugin, Gerard. Compt. Rend., Ser. A; 274: No. 7, 602-4(14 Feb 1972). (In French).

The method previously developed and the results obtained are extended to magnetohydrodynamics in special relativity theory. (France)

34492 SELF-EXCITATION IN SOME SYMMETRICAL SYSTEMS. Kobzar, A. I.; Yantovskii, E. I. Magn. Gidrodin.; No. 3, 3-14(Jul-Sep 1971). (In Russian).

The dependence of the magnetic field on time coordinates during steady-state symmetrical flow of a compressible conducting medium with large magnetic Reynolds numbers is examined in the absence of an external magnetic field. The requisite conditions are formulated for self-excitation of the magnetic field. The class of symmetric flows are denoted that comply with these conditions: flows of compressible fluids and the existence of penetrable walls. Possibility of the inception of self-excitation is determined by the spectrum of a certain linear differential operator. The boundary-value problem at special values is examined for a transverse magnetic field in a shaped channel. The minimum critical magnetic Reynolds number is about 2 to 4 for an assigned velocity change for the liquid along the channel. (tr-auth)

34493 DELAY IN THE TRANSITION TO TURBULENCE IN MAGNETOHYDRODYNAMICS. Levin, B. Magn. Gidrodin.; No. 3, 23-6(Jul-Sep 1971). (In Russian).

A semi-empirical evaluation of the increase in the Reynolds number in a transition to turbulence during finite perturbations is given. A similarity of the corresponding neutral curves, which would permit simple estimates, is shown. As an example, the transition to turbulence is examined during delayed laminar flow in a pipe. For simplicity, it is considered that the regime of flow around the source of the disturbance is similar to the Reynolds number, and is not dependent on the magnetic field. Under these conditions, an increase of the critical Reynolds number in the longitudinal magnetic field is weakly dependent on the initial disturbances and approximately equal to the increase in this same field of the minimum critical Reynolds number. (tr-auth)

34494 POSSIBILITIES TO CREATE AND INVESTIGATE TWO-DIMENSIONAL TURBULENCE IN A STRONG MAGNETIC FIELD. Kit, L. G.; Tsinober, A. B. Magn. Gidrodin.; No. 3, 27-34(Jul-Sep 1971). (In Russian).

Experimental results on MHD flows that acquired a two-dimensional structure in a strong magnetic field are analyzed. A complete, natural explanation of these results is presented in terms of two-dimensional turbulence. A basic property of the latter is its inability to impart energy upward along the structure (an absence of the Kolmogorov–Richardson mechanism). Additionally, these results show that a magnetic field is the instrument for realizing two-dimensional nonlinear flows, for example, two-dimensional turbulence. The problem of the transition of three-dimensional turbulence into two-dimensional is considered. (tr-auth)

34495 REALIZATION OF A LAMINAR MHD FLOW REGIME IN AN ANNULAR CHANNEL AT LARGE REYNOLDS NUMBERS. Gel'fgat, Yu. M.; Kit, L. G.; Peterson, D. A.; Tsinober, A. B. Magn. Gidrodin.; No. 3, 35-42(Jul-Sep 1971). (In Russian).

Laminar flow with complete absence of velocity fluctuations at Reynolds numbers that greatly surpass critical was accomplished in a ring-shaped MHD channel. A clear intermittence pattern was fixed at Ha/Re values that agreed with critical values of this parameter obtained in resistance measurements of prismatic pipes. Numerical calculations showed that, during flow in an annular channel, the intensity of the second vortex rapidly decreased in accordance with the growth of the magnetic field. (tr-auth)

34496 CHANGES IN INTENSITY AND IN SPECTRA OF A PULSED ELECTRIC FIELD ALONG A CHANNEL OF RECTANGULAR CROSS SECTION IN A CONSTANT TRANSVERSE MAGNETIC FIELD. Kit, L. G.; Platnieks, I. A. Magn. Gidrodin.; No. 3, 43-7(Jul-Sep 1971). (In Russian).

Using a three-electrode sensing element in a rectangular channel, the length of whose side is perpendicular to the magnetic field, measurements were made on the intensity of two components of a pulsating electric field. The intensity of the perturbations dropped in a strong field during recession of the cross section from the leading section of the magnet. A dimensionless component of the potential gradient was directed along the magnetic field, and was equal to the corresponding dimensionless component of the electric current density. With increase of the field these components dropped off practically to zero. This change in the density of the pulsed electric field is traced to large values of induction in the current which is preserved by the form of the two-dimensional perturbation perpendicular to the field. (tr-auth)

34497 MHD FLOW IN A SQUARE DUCT WITH WALLS OF VARYING CONDUCTIVITY IN A SLANTED TRANSVERSE MAGNETIC FIELD. Butsenieks, I. E.; Vitolin'sh, G. A.; Gel'fgat, Yu. M.; Dorofeev, V. S.; Shcherbinin, E. V. Magn. Gidrodin.; No. 3, 53-60(Jul-Sep 1971). (In Russian).

The dynamic and electromagnetic flow characteristics of a conducting-fluid in a square duct were studied theoretically and experimentally. It was assumed that the duct possessed two conducting and two non-conducting walls. A transformation pattern was obtained for the flow structure with change in the angle of inclination of the magnetic field relative to one of the duct walls. Despite the significant difference in the flow parameters, the experimental results satisfactorily agreed with the calculated values. (tr-auth)

34498 FLOW OF A CONDUCTING FLUID IN A RECTANGULAR CHANNEL. Isers, A. B.; Tarapov, I. E. Magn. Gidrodin.; No. 3, 61-6(Jul-Sep 1971). (In Russian).

The steady-state flow of a viscous fluid in a duct of infinite length and rectangular cross section was examined in crossed periodic electric and fixed magnetic fields. The magnetic field was oriented parallel to the conducting wall of the duct; two other walls were nonconducting. An approximate expression was obtained for the flow velocity and potential distribution. (tr-auth)

34499 MAGNETIC FIELD DISTRIBUTION IN A PLANE MHD CHANNEL. Bertinov, A. I.; But, D. A.; Nikitin, Yu. M.; Chitechyan, V. I.; Yudas, V. I. Magn. Gidrodin.; No. 3, 73-9(Jul-Sep 1971). (In Russian).

Two-dimensional distribution of the magnetic field in a linear MHD channel was investigated. The duct was surrounded by a nonmagnetic medium at significant magnetic Reynolds numbers R_m. The duct was formed by gently shaped lateral walls and parallel electrodes, and had large branches oriented normal to the electrode surfaces. Under conditions where end effects were suppressed, the distribution of the magnetic field was reduced to the Fredholm integral equation for transverse magnetic induction susceptible to computer treatment. (tr-auth)

34500 FREE CONVECTION OF A CONDUCTING FLUID IN A TRANSVERSE MAGNETIC FIELD. Zhivov, M. Z.; Sokovishin, Yu. A.; Stepanov, V. F. Magn. Gidrodin.; No. 3, 80-4(Jul-Sep 1971). (In Russian).

The free convective motion of a conducting fluid near a vertical plate in a homogeneous, transverse magnetic field is examined for an exponential decrease in temperature, with the physical properties of the fluid remaining unchanged. The calculations use an implicit difference method. The magnetic field retards the current and reduces heat exchange. A special feature arises for $m_1 > 0$, when the maximum temperature, beginning with some section, is displaced into the thermal boundary layer. Using a graph of the dimensionless heat flux, optimum dimensions are established for the heat exchange. Results of the numerical calculations of heat exchange are compared with results obtained by the Karman—Pol'gauzen integral method. (tr-auth)

34501 ROTATION OF CONDUCTING FLUID BETWEEN DISCS OF FINITE DIMENSIONS IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Gorbachev, L. P.; Molashenko, V. S.; Potanin, E. P. Magn. Gidrodin.; No. 3, 91-4(Jul-Sep 1971). (In Russian).

Axially symmetrical rotational movement of an electrically conducting fluid between dielectric disks with a finite radius is studied under the action of radial electric and axial magnetic fields and in the presence of boundary layers. The magnetic field is assumed to be proportional to r^{2n}. The Hall current is neglected. A method of fractional computation of inertial terms is used. (tr-auth)

34502 MAGNETOHYDRODYNAMIC BOUNDARY LAYER AT LARGE STEWART NUMBERS. Glazov, O. A. Magn. Gidrodin.; No. 3, 95-106(Jul-Sep 1971). (In Russian).

MHD boundary layer equations for a disk and for longitudinal flow around a rotating body for extremely general assumptions relative to the external stream are solved. The solutions are useful in the region of large values of the local Stewart number. The solutions of the boundary layer equations for the disk contained a series of solutions for special cases of the disk problem. (tr-auth)

34503 CONDUCTIVE MHD CHANNEL WITH CONDUCTING WALLS. Birzvalk, Yu. A.; Lietuvietis, O. I. Magn. Gidrodin.; No. 3, 111-17(Jul-Sep 1971). (In Russian).

The problem of potential distribution in the channel of a conductive MHD machine was solved, allowing for conducting walls positioned perpendicular to the magnetic field and along the length of the channel. Walls perpendicular to those mentioned were neglected. The method of calculation is presented in detail. Dimensionless integrals, which characterize the currents in the channel, are given, and, for particular cases, numerical values are calculated. (tr-auth)

34504 FLUID PRESSURE IN A CYLINDRICAL CHANNEL IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Burlaka, N. F.; Kudrenko, G. V.; Chekin, B. V.; Shchelukhin, E. M. Magn. Gidrodin.; No. 3, 145-7(Jul-Sep 1971). (In Russian).

An expression for the determination of pressure in an infinite cylindrical channel in crossed electric and magnetic fields is given. The electric field was produced by means of electrodes placed on the exterior surfaces of the channel walls. The effect of the relative conductivity and the thickness of the conducting layer on the pressure is shown, where the pressure is produced by electromagnetic forces. The results of experimental studies are given. (tr-auth)

34505 CALCULATION OF THE ELECTRIC FIELD IN A TWO-LAYER CONDUCTIVE FLUID OF A CONDUCTION MHD DEVICE. Chekin, B. V.; Smirnov, V. A. Magn. Gidrodin.; No. 3, 147-50(Jul-Sep 1971). (In Russian).

The problem of the electric field distribution in a rectangular MHD channel of finite length was solved in a non-inductive approach, where the channel was filled with two immiscible fluids of different conductivities. The solution is submitted in the form of infinite series involving trigonometric and hyperbolic functions. (K.S.W.)

34506 ALIGNED-FIELDS MAGNETOGASDYNAMIC FLOW THROUGH NOZZLES. Watanabe, Harry Hajime. Ann Arbor, Mich.; Univ. of Michigan (1971). 135p. University Microfilms Order No. 72-15,038.

Thesis.

When a magnetic field is applied to the flow of a magnetoactive gas through a nozzle, it is found that the pressure distribution must be altered to accommodate the new forces due to the interaction of the flow and the magnetic field. A perturbation method is applied to investigate the effects of these forces on the flow field. In the case where Mach numbers in the throat region approach one, it is found that the transonic character of the flow prevails. This seems to be the case even when the Alfvén number approaches one. The sample calculations clearly show that transonic flows with supersonic pockets cannot be obtained by ordinary perturbation methods. On the other hand they indicate that nozzle flows with Alfvén transitions are nonsingular and do not exhibit the buildup of singularities in the higher-order corrections. In seeking a family of flows in which the symmetric transonic flows develop into fully accelerating Meyer flows, the various cases of MGD aligned flows are offered by the Tomotika—Tamada transonic similarity solutions. Because of the sharp gradients indicated by these and previous symmetric solutions, it is necessary to take account of dissipative effects to smooth out the resulting shock layer. It is found that under conditions of a weak shock interaction, heat transfer due to the highly mobile electrons is the dominant dissipative mechanism within the shock layer. A sample calculation of the shock layer is made for the special case $A_* = 1$. Contrary to previous opinions, it is concluded that the shock layer equation yields a unique solution that depends on the external inviscid flow. (Diss. Abstr. Int., B)

34507 STEADY-STATE FLOW OF A CONDUCTING FLUID IN A RECTANGULAR CHANNEL WITH SEGMENTED WALLS. Malov, Yu. I.; Martinson, L. K.; Pavlov, K. B. Magn. Gidrodin.; No. 3, 67-72(Jul-Sep 1971). (In Russian).

The steady-state flow of a viscous, incompressible, isotropic, conducting fluid in a rectangular duct was investigated. A solution in the form of an infinite series was obtained for four problems corresponding to ducts with walls designed with certain combinations of insulators and conductors. Numerical calculations are given for the velocity distribution and induced magnetic field at given flow patterns. (tr-auth)

34508 MOTION OF A PLASMA CLUSTER IN AN AXIALLY SYMMETRIC MAGNETIC FIELD. Bass, V. P.; Belik, N. P.; Kozlovskii, E. E. Magn. Gidrodin.; No. 3, 15-18(Jul-Sep 1971). (In Russian).

In a linear arrangement formulas were obtained for angular and linear velocities of a bundle, and for current in the circuit of an accelerating system. A comparison is made between the results of the linear and nonlinear arrangements, and the analysis shows that the effect of the nonlinearity is insignificant. (tr-auth)

34509 ELECTROMAGNETIC FORCES ACTING ON PARTICLES OF A NONHOMOGENEOUS MEDIUM. Dobychin, I.; Popov, V. I. **Magn. Gidrodin.; No. 2, 29-32(Apr-Jun 1971). (In Russian).**

A solution is obtained for the problem concerning the total force acting on a given particle in a nonhomogeneous medium in crossed electric and magnetic fields in a conducting fluid medium. The effective conductivity of a two-phase medium is studied as a function of the concentration of the dispersed phase. The dependence of the electromagnetic force on the current density and concentration is investigated. The coefficients of electromagnetic ejection are found for conducting and nonconducting occlusions in the conducting carrier fluid under constrained conditions at different concentrations of the dispersed phase. (tr-auth)

34510 VORTICAL MHD FLOW IN A CONE. Shilova, E. I.; Shcherbinin, E. V. **Magn. Gidrodin.; No. 2, 33-8(Apr-Jun 1971). (In Russian).**

The problem of flow in a funnel established by vortical lines or by a system of radially convergent currents is examined. The character of the action on such a flow of a magnetic field of induced currents is demonstrated in one case. (tr-auth)

34511 EFFECTIVE METHOD OF INVESTIGATING ELECTROMAGNETIC PROCESSES IN MHD DUCTS. I. Kozyrenko, V. E. **Magn. Gidrodin.; No. 2, 39-44(Apr-Jun 1971). (In Russian).**

One of the most significant elements of the analytical method for investigating electromagnetic processes in MHD channels is the technique of constructing general solutions of elliptical systems of equations describing these processes, based on the establishment of a relation between them and the equations of Laplace. A system of equations which describe the longitudinal effects in channels for moderately-sized numbers R_m is considered here. The method of I. N. Bekua also yielded comparable results. (tr-auth)

34512 HADAMARD–RYBCZYNSKI PROBLEM IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Popov, V. I.; Tsinober, A. B. **Magn. Gidrodin.; No. 2, 59-62(Apr-Jun 1971). (In Russian).**

The slow, steady-state motion of a particle in a viscous, conducting fluid is analyzed under the action of a gravitational force in crossed homogeneous electric and magnetic fields at $Re_m \ll 1$, and $Ha^2/Re \ll 1$. The field of velocities and the inner and outer pressures of the particle are obtained; also, the dependence of the particle's velocity on all parameters of the problem is studied. (tr-auth)

34513 BOUNDARY LAYER OF A HIGH TEMPERATURE GAS JET IN THE PRESENCE OF A LONGITUDINAL MAGNETIC FIELD. Kuznetsov, A. P. **Magn. Gidrodin.; No. 2, 63-8(Apr-Jun 1971). (In Russian).**

Flow in a plane layer is investigated at the boundary of a turbulent, nonisothermal jet, as well as the flow in the boundary layer of a jet of ionized gas in the presence of a longitudinal magnetic field. (tr-auth)

34514 MHD CHANNEL FLOWS AT LARGE MAGNETIC REYNOLDS NUMBERS. Kovbasyuk, V. I.; Medin, S. A. **Magn. Gidrodin.; No. 2, 69-74(Apr-Jun 1971). (In Russian).**

The flow of a conducting fluid in the channel of an MHD generator is examined at large magnetic Reynolds numbers. The magnetic induction equation is written for magnetic systems with steel, and the possibility of magnetic saturation was assumed. The minimum of a function in generalized channel coordinates is sought (for example, the length of the volume). An analysis of the boundary conditions of the problem is made, and the conditions at the point of inflection are considered for inductive saturation. For a compressible fluid with variable conductivity a numerical solution is obtained; an analytical solution for the case of the incompressible fluid is presented. (tr-auth)

34515 CYLINDRICAL CONDUCTING MHD CHANNEL. Zanders, Yu. K. **Magn. Gidrodin.; No. 2, 113-22(Apr-Jun 1971). (In Russian).**

The operation of an MHD channel of circular cross section is analyzed with an arbitrary number of pole pairs and electrodes, arranged along the surface of the cylinder and on angular coordinates. It is assumed that the conducting fluid is incompressible, homogeneous, and isotropic, and moves with a constant velocity relative to the cross section of the channel; the magnetic field of the currents flowing through the channel is compensated by return current-carrying busbars. The three-dimensional distribution of the external magnetic field and the current density in the channel is found for the situation when the magnetic induction and current density are assigned fixed values at the poles and electrodes. The integral electrical characteristics of the MHD channel are determined for the respective regimens of generator and pump. (tr-auth)

34516 FORMATION OF A VELOCITY PROFILE IN THE ACCELERATION REGION NEAR A PLATE IN THE PRESENCE OF AN ELECTROMAGNETIC FIELD. Podushchak, A. A. **Magn. Gidrodin.; No. 2, 143-4(Apr-Jun 1971). (In Russian).**

In an electromagnetic field, systems of longitudinally alternating electric and magnetic fields on the surface of a plate, around which a conducting fluid flows, may form under certain conditions an asymptotic, laminar, boundary layer. The mathematical development yields an approximate analytical relation, which fixes the parameters of the boundary layer at a desired point along the length of the plate. (K.S.W.)

34517 THREE-DIMENSIONAL MHD FLOW PAST A CYLINDER OF FINITE LENGTH. Kolesnikov, Yu. B.; Tsinober, A. B. **Magn. Gidrodin.; No. 2, 144-6(Apr-Jun 1971). (In Russian).**

Experimental results are presented which show that, during flow around a cylinder of finite length in a transverse magnetic field, all major regions of flow become three-dimensional in proportion to the increase of the magnetic field. (K.S.W.)

34518 EXACT SOLUTION OF MAGNETOGASDYNAMIC EQUATIONS. Sapunkova, O. M. **Magn. Gidrodin.; No. 4, 3-10 (Oct-Dec 1971). (In Russian).**

Plane, steady-state, adiabatic currents of ideal plasma in a magnetic field are examined, where the magnetic lines of force coincide with the current lines. The equations of motion are depicted in the plane of a hodograph in a form analogous to the equations of Chaplygin. Accurate solutions to these equations were obtained which corresponded to a spiral current flowing around an edge, an outflow from an infinite vessel, and the stream in a jet. The problem of limiting lines, on which the lines of current have a point of return, was studied in detail. (tr-auth)

34519 QUALITATIVE INVESTIGATION OF ONE-DIMENSIONAL STEADY-STATE MHD FLOW OF A CONDUCTING GAS. Vulis, L. A.; Gusika, P. L.; Zhizhin, G. V. **Magn. Gidrodin.; No. 4, 11-17(Oct-Dec 1971). (In Russian).**

The differential equations of a stable, one-dimensional MHD stream of a nonviscous, nonheat-conducting gas were studied with the aid of a three-dimensional phase diagram. The gas was assumed to possess a finite electrical resistance. A qualitative picture of the possible flow patterns was constructed, which helped to define stable and unstable regions of the equilibrium states. The critical current velocity in a stable equilibrium state conformed with the effective magneto-acoustic velocity and may assume values over the interval from the usual gasdynamic velocity of sound in a non-conducting gas to a magneto-acoustic velocity in an infinitely conducting plasma. (tr-auth)

34520 HYDRODYNAMIC STABILITY OF PLANE FLOWS OF CONDUCTING DILATANT FLUIDS IN TRANSVERSE MAGNETIC FIELDS. Pavlov, K. B. **Magn. Gidrodin.; No. 4, 25-30(Oct-Dec 1971). (In Russian).**

The problem of hydrodynamic stability of a plane, laminar flow of a conducting, dilatant fluid is examined, where the liquid moves over an infinite plate in a transverse magnetic field. The stream is characterized by the formation of a finite zone in which is localized tangential stresses of shift. Neutral stability curves are obtained. (tr-auth)

34521 STABILITY OF AZIMUTHAL FLOW RESULTING FROM A ROTATING MAGNETIC FIELD. Kapusta, A. B.; Dremov, V. V.; Bartoshuk, E. S. **Magn. Gidrodin.; No. 4, 31-5 (Oct-Dec 1971). (In Russian).**

The stability of an azimuthal, dissipative flow of an incompressible, electrically conductive fluid in a tube of infinite length and circular cross section is investigated, wherein the flow results from a rotating, homogeneous, magnetic field of the form $H_0 \exp i(\omega t - \varphi)$. The axis of rotation coincides with the tube axis. The system of MHD equations that describe, in a noninductive approach, the axially symmetric rotation of the fluid is investigated by the method of small perturbations for stability of the original steady-state flow. The critical value of the Hart-mann number and of the wave number for various values of the criterion $Re_{\omega} = \omega R_0^2/v$ can be evaluated from a solution of the given system by the method of Galerkin. The second steady-state flow is formulated in the form of a double vortex layer. Good agreement of experimental and calculated values of Ha_{crit} is noted. (tr-auth)

34522 LAMINAR MHD BOUNDARY LAYER ON A CONDUCTIVE SURFACE TAKING INTO ACCOUNT TRANSVERSE VELOCITY COMPONENTS AND THE BRAKING FORCE. Kuznetsova, T. D.; Levitan, Yu. S.; Murav'ev, E. V.; Panevin, I. G. Magn. Gidrodin.; No. 4, 36-42(Oct-Dec 1971). (In Russian).

The development of a profile of lateral velocity components during diagonal inflow of electrically conductive fluid on a conducting surface was investigated in a field of a braking force with and without a pressure gradient. A break in the lateral velocity components did not occur as in the usual forward flow with a braking force, but stratification of the flow, that is, flow lines adjacent to the wall bent more strongly than in the layers farther removed. The lateral velocity did not exhibit any effect on the development of a boundary layer along the longitudinal axis. (tr-auth)

34523 EFFECTIVE METHOD FOR INVESTIGATING ELECTROMAGNETIC PROCESSES IN MHD CHANNELS. II. Kozyrenko, V. E. Magn. Gidrodin.; No. 4, 43-8(Oct-Dec 1971). (In Russian).

Discontinuous boundary problems concerning the theory of MHD channels lead to a combined boundary-problem theory of functions of one complex variable and general method of their solution in a closed form. Accordingly, electromagnetic processes in MHD channels were investigated. In the case of an MHD channel with a single pair of electrodes, closed to $+\infty$, for a constant conductivity of current, and a homogeneously applied magnetic field, with an increase of R_m there is a manifest tendency toward the formation of a current vortex. The vector of electric current density in this case is attenuated at the entry in the area between the electrodes and is intensified at the exit. (tr-auth)

34524 CALCULATION OF FORCES IN A CONDUCTING FLUID BETWEEN TWO FERROMAGNETIC CYLINDERS. Kapusta, A. B.; Trunova, T. S.; Titarenko, N. G. Magn. Gidrodin.; No. 4, 49-52(Oct-Dec 1971). (In Russian).

Electromagnetic processes in a region bounded by two plane surfaces and two cylindrical surfaces are examined. The distribution of induction in an electrically conducting fluid located between two ferromagnetic cylinders is found, using a finite integral transformation method and Galerkin's method. From these results an approximation expression is obtained for determining the current density. The three-dimensional distribution of forces was computed electronically. (tr-auth)

34525 MHD FLOW IN A CHANNEL IN AN INCLINED MAGNETIC FIELD. Tsinober, A. B.; Shtern, A. G. Magn. Gidrodin.; No. 4, 143-4(Oct-Dec 1971). (In Russian).

Flow in a plane channel in a homogeneous magnetic field was studied, where the field was inclined at some angle between 0 and $\pi/2$ to the wall of the channel. For a comparatively large value of the induced magnetic field, an extremely large pressure drop was evident in an experimental apparatus using sodium in a rectangular stainless steel channel 60×8 mm^2. (K.S.W.)

34526 EFFECT OF JOULE DISSIPATION ON THE CONVECTIVE INSTABILITY OF A CONDUCTING FLUID WITH A CURRENT IN A MAGNETIC FIELD. Eismont, O. A. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 1, 19-22(Jan-Feb 1972). (In Russian).

The results of previous work on the convective motion of a conducting fluid with a current in a transverse magnetic field were extended to the case in which Joule dissipation leads to a nonlinear profile of the disturbed temperature of a fluid. The approach used allowed the use of an energy equation which lacked electromagnetic terms. In many cases, the Joule dissipation is significant and may have a distinct effect on the development of convective instability. Without allowing for Joule heat release, instability may arise only for positive Rayleigh numbers that exceed some critical value, whereas Joule dissipation may lead to a situation in which instability develops also at negative Rayleigh numbers. (tr-auth)

34527 STABILITY OF A PLANE IONIZING SHOCK WAVE IN A MAGNETIC FIELD. Sinkevich, O. A. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 1, 122-8(Jan-Feb 1972). (In Russian).

In the presence of a constant transverse magnetic field a plane, ionizing, gasdynamic shock wave attains greater stability with respect to a small displacement of its front from a position of equilibrium. The development centers around the movement of the shock wave along an MHD duct; the Hall effect and the effects of temperature and viscosity are neglected. (K.S.W.)

34528 MHD FLOW OF THE ROLLING-WAVE TYPE IN A PERPENDICULAR MAGNETIC FIELD. Vishnyakov, V. I.; Pavlov, K. B. (Moscow Higher Technical School). Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 1, 162-8(Jan-Feb 1972). (In Russian).

The motion of two interacting viscous media of arbitrary conductivity is examined in an inclined duct with nonconducting walls, situated in a transverse magnetic field. An asymptotic method used describes the steady-state flow from the wave surface dividing the two media. A dependence of the wave form and length on the parameters of the problem is found, and numerical values are determined for some of these. A rolling-wave theory is constructed for investigating the steady-state, long, gravitational wave that arises in inclined, open ducts. (tr-auth)

34529 ELECTROHYDRODYNAMIC JETS BEHIND A SHEARING SOURCE OF CHARGED PARTICLES. Grabovskii, V. I. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 1, 200-5(Jan-Feb 1972). (In Russian).

Phenomena occurring in a jet of an incompressible fluid extending behind a shearing source of charged particles are investigated. Within the framework of one-dimensional theory, it is shown that the presence of a regime of maximum takeout current from the source is a regime of saturation. This current may decrease significantly during removal of the surface collector from the grounded source. A numerical solution to the two-dimensional problem was obtained with the aim of studying the distribution of electrostatic parameters in a plane channel with conducting walls. (K.S.W.)

PHYSICS (HIGH-ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 34590.

Electromagnetic

Refer also to abstract 33489.

34530 (JINR–P1-6289) INVESTIGATION OF THE ELECTROMAGNETIC STRUCTURE OF THE PION, Δ (1236) ISOBAR, AND NEUTRON IN A SINGLE PION ELECTROPRODUCTION. Smirnov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 26p. (In Russian). Dep. NTIS (U.S. Sales Only).

The review deals with some problems, concerning extraction of information on the pion electromagnetic form factor F_π (k^2), ($\gamma N\Delta$)-transition form factor $G_M^*(k^2)$ and the neutron electric form factor G_{En} (k^2). Experiments on pion electroproduction are compared with those used in studying the electromagnetic structure of elementary particles. The role of uncertainties in the theoretical models in form factor determination is discussed. (auth)

34531 (LAL-1260) STUDY OF THE ANNIHILATION REACTIONS $e^+e^- \rightarrow \omega \rightarrow \pi^+\pi^-\pi^0$ AND $e^+e^- \rightarrow \phi \rightarrow \pi^+\pi^-\pi^0$ PRODUCED IN THE ORSAY COLLISION RINGS. Jean-Marie, B. (Paris Univ., Orsay (France). Faculte des Sciences). Mar 1972. 170p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Cross sections for the interactions $e^+ + e^- \rightarrow \omega(\phi) \rightarrow \pi^+ + \pi^- + \pi^0$ are found. The total widths of the ω and ϕ are determined, and the width of the decay mode $\phi \rightarrow 2\pi + \gamma$ is studied. (J.F.P.)

34532 (LAL–1261) STUDY OF RADIATIVE DECAYS OF VECTOR MESONS ω^0 AND ϕ^0 BY e^+e^- ANNIHILATION. Cosme, Gerard (Paris Univ., Orsay (France). Faculte des Sciences). Apr 1972. 140p. (In French). Dep. NTIS (U.S. Sales Only).

The reaction $e^+ + e^- \rightarrow \omega(\phi)$ in colliding beams is studied using spark chambers. The cross sections and branching ratios for $\omega^0 \rightarrow \pi^0(\eta^0) + \gamma$, $\omega^0 \rightarrow 2\pi^0 + \gamma$, and $\phi^0 \rightarrow \pi^0(\eta^0) + \gamma$ decays are found. (J.F.P.)

34533 (NP–19320) MEASUREMENT OF ELECTROPRODUCTION OF THE Δ(1236) RESONANCE ON PROTONS AND NEUTRONS. Bleckwenn, J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jan 1972. 99p. (In German). Dep. NTIS (U.S. Sales Only).

Cross sections for electroproduction on protons and neutrons were investigated by momentum analysis of scattered electrons. For momentum transfers $0.1 < (-q^2) < 0.5$ $(GeV/c)^2$ and invariant masses $W < 1.4$ GeV of the final hadronic state the measured cross section was split up into a resonant and a nonresonant contribution. The transition form factor $G_M^*(q^2)$ of the $\gamma N\pi$-vertex was derived from the resonant cross section. The equality of resonant respective nonresonant part of the excitation cross section on protons and neutrons permits one to derive upper limits for isoscalar and isotensor currents to electroproduction processes. Total cross sections for absorption of real photons were derived from measured values by extrapolation to $q^2 = 0$. Furthermore, semilocal duality was tested for protons in the region of q^2 mentioned above. (auth)

34534 INFLUENCE OF ELECTRON DYNAMICS ON THE POLARIZATION PROPERTIES OF SYNCHROTRON RADIATION. Bagrov, V. G.; Nikitin, M. M. At. Energ. (USSR); 32: No. 3, 243-4(Mar 1972). (In Russian).

The vertical-angular distribution of the intensity of the π-component of polarization of electron radiation was investigated. This radiation effected a vertical betatron oscillation of fixed amplitude. A light beam was cut out, producing an image of a beam of electrons using a diaphragm with a minute opening. The results obtained supported the theory. (K.S.W.)

34535 TOTAL HADRONIC PHOTOABSORPTION CROSS SECTIONS IN VARIOUS ATOMIC NUCLEI AT HIGH ENERGIES. Hesse, William Peter. Santa Barbara, Calif.; Univ. of California (1971). 218p. University Microfilms Order No. 72-7460.

Thesis.

The hadronic nature of photon interactions with matter has been investigated by measuring the total hadronic photoabsorption cross section in hydrogen, deuterium, carbon, copper and lead for photons with incident energy in the 3.7 GeV to 18.3 GeV range. The experiment, performed at the Stanford Linear Accelerator Center, used a tagged bremsstrahlung photon beam. The hadronic and electromagnetic events produced by the incident photons were detected with lead-scintillator sandwich counters. (TSS) (Diss. Abstr. Int., B)

34536 WIDE-GAP SPARK CHAMBER STUDY OF $K_L^0 \rightarrow \pi^\pm +$ $e + \nu$ DECAY. Wang, Lichen. College Park, Md.; Univ. of Maryland (1971). 140p. University Microfilms Order No. 72-12,864.

Thesis.

A wide-gap spark chamber operated in a magnetic field of 10 KG was used to measure the energy dependence of the form factor f_+ (q^2) in $K_L^0 \rightarrow \pi^\pm + e^\mp + \nu$ decay. Decays of K_L^0 meson in a vacuum box were detected in the –30° neutral beam of the AGS at Brookhaven National Laboratory. K°e3 decays were identified by electromagnetic showers produced in a lead radiator plate between the two 12-inch gaps of the chamber. The linear parameter λ_+ of the form factor $f_+(q^2)$ is determined to be 0.040 ± 0.013 where the error includes possible systematic errors. A variety of other forms for the energy dependence were also studied. (Diss. Abstr. Int., B)

34537 PROTON–PROTON BREMSSTRAHLUNG AT 156 MeV FOR FORWARD ANGLES. Willis, A.; Comparat, V.; Frascaria, R.; (and others) (Institut de Physique Nucleaire, Orsay, France). Phys. Rev. Lett.; 28: No. 16, 1063-5(17 Apr 1972).

Proton–proton bremsstrahlung cross sections were measured at 156 MeV for the proton angles $\theta_1 = 15°$ and $\theta_2 = 18$, 21, 24, and 27°. The γ rays were detected with a Cherenkov counter. (auth)

34538 OBSERVATION OF WIDE ANGLE HADRONS IN DEEP INELASTIC ELECTRON SCATTERING. Kerchner, Robert Marc. Ithaca, N. Y.; Cornell Univ. (1971). 105p. University Microfilms Order No. 72-13,160.

Thesis.

The reaction $e + p \rightarrow e + p + \rho^0$ is measured by observing electron–proton coincidences for ν beyond the resonance region and for $-t = 0.07$ to 0.5 GeV². This noted that the yield of $p + \rho^0$ relative to other hadron final states is less than in photoproduction. (Diss. Abstr. Int., B)

34539 OPTICAL RADIATION EXCITED BY NONRELATIVISTIC CHARGED PARTICLES AT METAL SURFACES. Kobzev, A. P.; Mikhalyak, S.; Rutkovski, E.; Frank, I. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 2, 326-33(Feb 1972). (In Russian).

Polarization, angular distributions, and energy dependence were measured for radiation in the wavelength range 3800 to 6500 Å. The radiation was produced on the surface of Ag, Al, W, and Ni targets when bombarded by electrons at 0.5 to 15 keV and protons at 1.5 to 4.5 MeV. The polarized component is in good agreement with that calculated in the theory of transition radiation. (7 figures) (auth)

34540 $\pi^+\pi^-$ PRODUCTION BY e^+e^- ANNIHILATION IN THE ρ ENERGY RANGE WITH THE ORSAY STORAGE RING. Benaksas, D.; Cosme, G.; Jean-Marie, B.; (and others) (Paris Univ., Orsay, France). Phys. Lett.; 39B: No. 2, 289-93(17 Apr 1972).

A large solid angle detector was used to observe two body events produced by electron-positron collisions in the Orsay storage ring. From the $\pi^+\pi^-$ excitation curve in the ρ region the amplitude and the phase of the ω-ρ interference, and the ρ resonance parameters were deduced. (auth)

34541 $\pi^\pm$ AND π^0 PRODUCTION BY POLARIZED PHOTONS IN THE RESONANCE REGION. Alspector, J. (Massachusetts Inst. of Tech., Cambridge); Fox, D.; Luckey, D.; (and others). Phys. Rev. Lett.; 28: No. 21, 1403-6(22 May 1972).

The cross sections at 90° c.m. for $\pi^\pm$ and π^0 photoproduction were measured with polarized photons. The photon energies ranged from 0.8 to 2.2 GeV. The resonant "bumps" in the cross section are compared with theoretical models. The measured asymmetry agrees with a quark-model calculation, though the predicted cross sections are low. (auth)

34542 GAMMA–GAMMA INTERACTION PROCESSES AT ADONE e^+e^- STORAGE RING. MEASUREMENT OF THE REACTION $e^+ + e^- \to e^+ + e^- + e^+ + e^-$. Bacci, C. (Univ., Rome. Instituto Nazionale di Fisica Nucleare, Rome); Penso, G.; Salvini, G.; (and others). Lett. Nuovo Cim.; 3: No. 18, 709-14(29 Apr 1972).

Experimental results on the interaction $e^+ + e^- \to e^+ + e^- + e^+ + e^-$ at a total energy of 2 GeV are reported and compared with available theoretical calculations. The possible practical consequences for future research on $\gamma-\gamma$ interactions are pointed out. (L.B.S.)

34543 NEUTRAL-PION PHOTOPRODUCTION ON PROTON FROM DEUTERIUM IN THE ENERGY RANGE (400 TO 800) MeV. Bacci, C. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Baldini-Celio, R.; Esposito, B.; (and others). Lett. Nuovo Cim.; 4: No. 1, 5-8(6 May 1972).

A comparison is made of the differential cross sections for the reactions $\gamma + p \to \pi^0 + p$ and $\gamma + d \to \pi^0 + p + (n_s)$ at 400 to 800 MeV in order to test the validity of the impulse approximation. The results show a deviation of the ratio of the cross sections from one, which is interpreted as a final-state interaction effect. (L.B.S.)

34544 NOVOSIBIRSK COLLIDING BEAM EXPERIMENTS. Sidorov, V. A. (Nuclear Physics Inst., Novosibirsk, USSR). pp 65-72 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Some new results produced by analysis of data from two previous experiments at Novosibirsk using the electron–positron ring VEPP-2 are presented. These include: ϕ meson mass determination; test of quantum electrodynamics; measurement of π^+ and π^- electromagnetic form factors above the ρ resonance; some information about K^+ and K^- electromagnetic form factors above the ϕ resonance; evidence for the reaction $e^+e^- \to e^+e^-e^+e^-$; and probable multibody hadronic events. (L.B.S.)

34545 PHOTOREACTIONS BELOW 3 GeV. Donnachie, A. (Univ. of Manchester, Eng. Daresbury Nuclear Physics Lab., Lancashire, Eng.). pp 74-96 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

The latest state of the phenomenological analyses of photoreactions below 3 GeV is briefly discussed, starting with pion production above the first resonance region, then eta production and associated production. The first resonance region is then discussed. (L.B.S.)

34546 ELASTIC SCATTERING AND RESONANT ELECTROPRODUCTION. Wilson, Richard (Harvard Univ., Cambridge, Mass.). pp 97-114 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

The main features of elastic electron–nucleon scattering are summarized. Combined data on ep and en cross sections and electric and magnetic form factors are presented and discussed. Data on electroproduction of the first resonance at M = 1235 MeV are discussed along with models used to fit the data. (L.B.S.)

34547 DEEP INELASTIC ELECTRON SCATTERING IN THE CONTINUUM REGION. Kendall, Henry W. (Massachusetts Inst. of Tech., Cambridge, Mass.). pp 247-61 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

A review is given of the experimental knowledge derived from the deep inelastic electron measurements with regard to the range and validity of scaling, knowledge of the contribution of the longitudinal component of the exchanged photons to the results, and a brief discussion of the scaling variables used. The sum rule results are then discussed. The details are given on new measurements of the deep inelastic scattering of electrons from hydrogen and deuterium, and scattering from beryllium, copper, and gold at 4.5 to 19.5 GeV. Implications of the results are discussed. (L.B.S.)

34548 CONTINUUM ELECTROPRODUCTION BY COINCIDENCE MEASUREMENTS. Berkelman, Karl (Cornell Univ., Ithaca, N. Y.). pp 263-79 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Experimental studies of hadron production in continuum electroproduction by coincidence measurements are reported. These include forward single pion production, forward $\pi + \Delta$ production, other pseudoscalar production, forward vector meson production, and inclusive final states. (L.B.S.)

34549 TOTAL PHOTON DEUTERON HADRONIC CROSS SECTION IN THE ENERGY RANGE 0.265 TO 4.215 GeV. Armstrong, T. A. (Univ. of Glasgow); Hogg, W. R.; Lewis, G. M.; (and others). Nucl. Phys.; B41: No. 2, 445-73(1972).

The total cross section for photoproduction of hadrons on the deuteron, σ^d_T, was measured for photon energies in the range 0.265 to 4.215 GeV. From this, using results for the proton total cross section, obtained previously with the same apparatus, the neutron total cross section was determined in the resonance region. The resonant structure is found to be quite different from that for the proton. Thereafter the neutron cross section falls off steadily with energy, and the values obtained are consistently lower than those for the proton. Forward scattering amplitudes are evaluated for the deuteron. (auth)

34550 RECOIL PROTON POLARIZATION IN THE REACTION $\gamma p \to \pi^0 p$ IN THE THIRD RESONANCE REGION. Prentice, M. N. (Univ. of Glasgow); Railton, R.; Rutherglen, J. G.; (and others). Nucl. Phys.; B41: No. 2, 353-64(1972).

Measurements were made of the polarization of the recoil proton in the process $\gamma p \to \pi^0 p$ for photon energies of 850 to 1250 MeV and centre-of-mass angles of 80° to 125°. The results, which are to a typical accuracy of ±0.09, show a marked disagreement with previous phenomenological analyses above 1000 MeV. (auth)

34551 INELASTIC ELECTRON PROTON SCATTERING AT SMALL FOUR-MOMENTUM TRANSFERS AS A TEST OF FINITE-ENERGY SUM RULES. Moritz, J. (Univ., Karlsruhe, Ger. Kernforschungszentrum, Karlruhe, Ger.); Schmidt, K. H.; Wegener, D.; Bleckwenn, J.; Engels, E. Jr. Nucl. Phys.; B41: No. 2, 336-52(1972).

The twofold differential cross section for the inelastic scattering of electrons on protons was measured as a function of the scattered electron energy for an electron scattering angle of 12°. The kinematic region covered in this experiment was $0.3\ (\mathrm{GeV}/c)^2 < q^2 < 1.0\ (\mathrm{GeV}/c)^2$ and $W < 2.9$ GeV. The Bloom–Gilman as well as the constant scattering angle sum rule of Rittenberg and Rubinstein were tested. (auth)

34552 SEARCH FOR THE REACTION $\mu^- + \mathrm{Cu} \to e^+ + \mathrm{Co}$. Bryman, D. A.; Blecher, M.; Gotow, K.; Powers, R. J. (Virginia Polytechnic Inst. and State Univ., Blacksburg, Va.). Phys. Rev. Lett.; 28: No. 22, 1469-71(29 May 1972).

We have searched for the reaction $\mu^- + \mathrm{Cu} \to e^+ + \mathrm{Co}$, which is allowed by the lepton conservation scheme that assigns the same lepton number to e^-, μ^+, ν_e, and $\bar{\nu}_\mu$. One event was observed which was consistent with the above reaction, while the expected background was $\simeq 0.02$ events. Although we cannot be certain whether the process was detected, we can set an upper limit on the branching ratio relative to ordinary muon capture of $R \leq 2.6 \times 10^{-8}$ (90% confidence level). (auth)

34553 EXPERIMENTAL INVESTIGATION OF X RADIATION OF ULTRARELATIVISTIC ELECTRONS IN MAGNETIC ONDULATORS. Alikhanyan, A. I.; Esin, S. K.; Ispiryan, K. A.; (and others). JETP Lett. (USSR) (Engl. Transl.); 15: No. 3, 98-100(5 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.: 15: No. 3, 142-6(5 Feb 1972).

Preliminary results were presented of an investigation of emission from 3.6-GeV electrons in a magnetic ondulator at x-ray frequencies. Experimental results were previously given for an investigation of electrons in magnetic ondulators at millimeter and optical frequencies. The emission of ultrarelativistic electrons in magnetic ondulators at x-ray frequencies has been previously investigated theoretically. It was shown that in the case of a sinusoidal distribution of the field in the ondulator, the emission of the fast electrons consists of different harmonics with a given frequency interval. The total radiation energy, just as in the case of synchrotron radiation, is proportional to the square of the energy of the passing particle, whereas the total number of emitted quanta does not depend on the particle energy.

With increasing particle energy, the spectrum shifts toward shorter wavelengths. If radiation in a definite frequency interval is registered, then the number of photons, and also the energy carried away by the photons, should depend on γ of the primary particle, so that the fast-particle energies can be measured. The ondulator comprised a system of poles placed in the gap of a type SP-37 magnet along the beam direction such that their fields were perpendicular to the beam axis and reversed direction periodically along the axis. Electrons of energy 3.6 GeV were registered with two scintillation counters placed ahead and past the ondulator and were then deflected by a magnet. (J.C.W.)

34554 ANGULAR DISTRIBUTIONS FOR SINGLE NEUTRAL PION PHOTOPRODUCTION FROM NEUTRONS AT 450 TO 800 MeV. Bacci, I. (Istituto Nazionale di Fisica Nucleare, Rome); Baldini-Celio, R.; Esposito, B.; (and others). Phys. Lett.; 39B: No. 4, 559-62(15 May 1972).

Differential cross sections for single photoproduction of neutral pion on neutron were measured at different c.m. angles for photon energies, between 450 to 800 MeV. The results are compared with the existing theories and seem to favor the hypothesis of an appreciable presence of the P_{11} (1470) in the neutron photoexcitation. (auth)

34555 HADRONIC CONTRIBUTIONS TO THE MUON ANOMALOUS MAGNETIC MOMENT. Bramon, A.; Etim, E.; Greco, M. (CNEN, Frascati, Italy). Phys. Lett.; 39B: No. 4, 514-16(15 May 1972).

The hadronic contribution to the muon anomalous magnetic moment is calculated using recent results from colliding beam experiments; a value of $(68 \pm 9) \times 10^{-9}$ is obtained. (auth)

Weak

34556 POSSIBLE INTERPRETATION OF NEW EVENT IN COSMIC-RAY EXPERIMENT. Hayashi, Takemi; Kawai, Eiichiro; Matsuda, Masahisa; Ogawa, Shuzo; Shige-eda, Shinsei (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 280-7(Jan 1972).

Recently, Niu et al. have found an interesting event in the jet showers of cosmic ray experiment, which suggests the possible existence of a new particle not belonging to the conventional elementary particles. An analysis and an interpretation of this particle are presented. (auth)

34557 SEARCH FOR $\bar{\nu}_e + e^-$ SCATTERING. Gurr, Henry S.; Reines, Frederick; Sobel, Henry W. (Univ. of California, Irvine). Phys. Rev. Lett.; 28: No. 21, 1406-9(22 May 1972).

An improved cross-section upper limit of 1.9 times that of V–A theory was determined for the reaction $\bar{\nu}_e + e^- \rightarrow \bar{\nu}_e + e^-$. The target, a 7.84-kg plastic scintillator, was enclosed by a composite 330-kg NaI and 2200-liter liquid anticoincidence detector, and was operated in a fission $\bar{\nu}_e$ flux of 2.2×10^{13} cm^{-2} sec^{-1}. Some constraints which this limit imposes on theoretical conjectures are noted. (auth)

34558 MEASUREMENT OF DECAY CORRELATIONS IN $K^+_{\mu 3}$ DECAYS. Ankenbrandt, C. (Brookhaven National Lab., Upton, N. Y.); Larsen, R.; Leipuner, L.; (and others). Phys. Rev. Lett.; 28: No. 22, 1472-5(29 May 1972).

Wire spark planes and scintillation counters were used in an experiment designed to measure the correlations among the products of the decay of a stopped K^+ meson to a muon, neutrino, and pion. The results determined the value of the form-factor ratio as $\xi(0) = -0.62 \pm 0.28$. The momentum dependence of the f_+ form factor was defined by our measured value of $\lambda_+ = 0.024 \pm 0.022$ (taking $\lambda_- = 0$.) (auth)

Strong (Baryon-induced)

Refer also to abstract 34639.

34559 (JINR–P1-6358) ON THE SLOPE PARAMETER OF THE ELASTIC pp-SCATTERING DIFFERENTIAL CROSS SECTION. Chernev, Kh. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The slope parameter of the elastic pp-scattering differential cross section is determined for the six given $|t|$ values at the energy of >0.5 GeV. It is shown that in the experiments at the CERN Intersecting Storage Rings the slope parameter increases proportionally ln s in all $|t|$ intervals. The coefficient "C" in the parametric representation of the differential cross section $d\sigma/d|t| = \exp(a + b\,t + ct^2)$ is determined for the energy range of 8 to 1000 GeV. (auth)

34560 (NP–19316) STUDY OF THE 1500 AND 1700 MeV ENHANCEMENTS IN THE $p\pi^+\pi^-$ MASS IN THE REACTION $pp \rightarrow pp\pi^+\pi^-$ AT 19 GeV/c. Johnstad, H.; Moellerud, R.; Veje, L.; (and others) (Helsinki Univ. (Finland). Dept. of Nuclear Physics). 1971. 35p. Dep. NTIS (U.S. Sales Only).

The 1500- and 1700-MeV enhancements observed in the $p\pi\pi$ system are analyzed. It is found that the 1500 MeV effect is not a pure angular momentum state. Neither t- nor s-channel helicity is conserved. The 1700 MeV effect gives good fits to $J = 3/2$ and $5/2$ decaying to $p\pi\pi$. In the decay mode $\Delta^{++}\pi^-$ $J = 5/2$ is preferred over $3/2$. Moment analysis shows consistency with t- rather than s-channel helicity conservation. (Finland)

34561 ESTIMATION OF THE CONTRIBUTION OF BEAM-GAS COLLISIONS TO THE PION FLUX EXPECTED AT LARGE ANGLES FROM THE INTERSECTING STORAGE RINGS. Anghelescu, D.; Bogdan, B.; Datcu, V.; Friedlaender, E. M. (Institutul de Fizica Atomica, Bucharest). Bul. Inst. Politeh. Gheorghe Gheorghiu-Dej Bucuresti; 33: No. 2, 33-9(Mar-Apr 1971). (In Rumanian).

A yield of $\approx 2 \times 10^{-2}$ low momentum (<150 MeV/c) pions per collision with a light (C,N,O) nucleus was estimated at right angles from interactions of 22.6 GeV protons using nuclear emulsions. (auth)

34562 FAMILIES OF γ QUANTA WITH ENERGIES OF 120 AND 230 TeV IN THE FORMATION OF HEAVY (M = 1 GeV) AND SUPER-HEAVY (M = 7 GeV) CLUSTERS. Apanasenko, A. V.; Baradzei, L. T.; Smorodin, Yu. A.; Solopov, E. A. Kratk. Soobshch. Fiz.; No. 10, 25-33(Oct 1971). (In Russian).

Discontinuous growth of clusters at energies exceeding 10^{14} eV as formed on nucleon collisions was investigated. The energy spectrum of γ quanta in families before and after unification into cascades is discussed. The families investigated were examples of the formation of heavy (M = 1 GeV) and super-heavy (M = 7 GeV) clusters in interactions at energies of the order of 10^{15} eV. (K.S.W.)

34563 $\bar{p}p$ ELASTIC AND CHARGE EXCHANGE SCATTERING AT 230 MeV. Kohno, H. (Hiroshima Univ.); Kaneko, S.; Murata, Y.; (and others). Nucl. Phys.; B41: No. 2, 485-92(1972).

Reactions $\bar{p}p \rightarrow \bar{p}p$ and $\bar{p}p \rightarrow \bar{n}n$ were studied at the kinetic energy 230 MeV of incident $\bar{p}$ by using bubble chamber films. Total cross sections for both of the reactions were found to be 51.2 ± 1.6 mb and 9.1 ± 0.6 mb, respectively. Differential cross sections are well explained by the phenomenological theory given by Bryan and Phillips. (auth)

34564 PION SPECTRA FROM THE REACTION $p + p \rightarrow \pi^\pm +$ ANYTHING AT 28.5 GeV. Sims, W. H. (Vanderbilt Univ., Nashville); Hanlon, J.; Salant, E. O.; (and others). Nucl. Phys.; B41: No. 2, 317-35(1972).

The single-particle inclusive pion spectrum from the reaction $p + p \rightarrow \pi^\pm +$ anything at 28.5 GeV is presented in both tabular and graphical form. The data are from exposures in the BNL 203 cm bubble chamber. The emphasis is on exhibiting the single-particle spectra in sufficient detail so that the data will be useful to those interested in testing models and developing new concepts. (auth)

Strong (Meson-induced)

34565 (IFVE-STF-71-4) KAON REGENERATION AND CONSTANCY OF THE TOTAL CROSS SECTIONS AT ENERGIES ABOVE 30 GeV. Aznauryan, I. G.; Solov'ev, L. D. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that measurement of the regeneration cross section at two energies: above 40 and below 20 GeV within a 10% error, as well as the measurement of the regeneration phase, allow one to check the constancy of the difference of the K^-n and K^+n total cross sections above 30 GeV. (auth)

34566 (INR–1342) COMPARATIVE STUDY OF HIGH MULTIPLICITY $\bar{\pi}p$ INTERACTIONS. Szeptycka, Maria (Institute of Nuclear Research, Warsaw (Poland)). 1971. 127p. (In Polish). Dep. NTIS (U.S. Sales Only).

The technique of longitudinal phase space (LPS) was applied to the study of six-prong $\bar{\pi}p$ events. The cross sections in the LPS sector and the results on resonance production in the sectors are given. The characteristics of events in different regions of the c.m.s. longitudinal momentum of protons was studied. The method of Van Hove plots was used to search for correlations between longitudinal momenta of secondary particles. (auth)

34567 (IS-T-495) MISSING MASS RECOILING AGAINST TWO PROTONS IN K^+d INTERACTIONS AT 4.2 GeV/c. White, Ralph Kendall (Ames Lab., Iowa). Apr 1972. Contract W-7405-eng-82. 73p. Dep. NTIS.

Thesis.

The missing-mass distribution was studied in K^+d interactions at 4.2-GeV/c beam momentum with two identified protons in the final state. The data were obtained from 250,000 frames taken in the MURA 30-inch bubble chamber at Argonne National Laboratory. The data sample consists of 4607 events, 1142 two-pronged events, 3233 four-pronged events, and 232 events having six prongs. V's, created from decays of neutral particles produced in a reaction into two charged particles, were given no special treatment and are included in these figures. Three-pronged events with one identified proton were not included because the mass resolution was very poor. Resonance production includes the known resonances, K*(890) and K*(1400); probable resonances referred to as K*(1760) and K*(1900), and possible states at 1200, 2180, and 2350 MeV. The K^0 is a metastable particle which decays by weak interactions and should appear as a narrow spike in the data. However, it is also observed to have a width in these data because the momentum and angles for every track of every event can not be determined exactly. Final states are of the form $p(p)X^0$ where the symbol (p) refers to the spectator proton expected in deuteron reactions and X^0 is an outgoing neutral system of particles having positive strangeness. The decay modes studied are (a) decay into all neutral particles from events having two prongs, (b) decay into two charged particles and two charged particles plus neutral particles from the four-pronged events with high momentum imbalance, (c) decay into two charged particles from the four-pronged events with low momentum imbalance and (d) decay into four charged particles and four charged particles plus neutrals from the six-pronged events. The experimentally determined branching ratios for the K*(890) are 0.28 ± 0.05 for decay into (a) and 0.72 ± 0.14 for decay into (b) and (c) assuming only two-body decay modes. The branching ratio for K*(1400) decay into (a) is 0.24 ± 0.04, into (b) and (c) is 0.34 ± 0.07, and into (d) is approximately 0. To calculate the branching ratios of the K*(1400), it is necessary to assume it to be an isospin ½ resonance. The cross section for K*(890) production is 127 μb and the cross section for K*(1400) production is 148 μb. The total inelastic production cross section is 30.0 ± 0.6 mb. (auth)

34568 COHERENT PRODUCTION OF THE KAON, PION, PION SYSTEM BY POSITIVE 3.8 GeV/c KAONS ON DEUTERIUM. Robinson, Michael Ray. Urbana, Ill.; Univ. of Illinois (1971). 143p. University Microfilms Order No. 72-12,355.

Thesis.

A study is presented of coherent $K\pi\pi$ production by 3.8-GeV/c K^+ particles in the deuterium-filled Argonne 30″ bubble chamber. The study is based on 934 events of the reaction $K^+d \rightarrow dK^+\pi^+\pi^-$ and 337 events of the reaction $K^+d \rightarrow dK^0 - \pi^+\pi^0$. Features of the $dK^+\pi^+\pi^-$ final state are compared with the distributions expected for pion exchange production of the K*(890) meson. Events associated with a 93-MeV/c^2 wide peak at 1.29 GeV/c^2 in the $K^+\pi^+\pi^-$ mass spectrum are investigated. Evidence that the narrow peak is due to resonance production is presented. There is enough evidence for resonance production so that the idea is tantalizing if not conclusive. The general features of both the reaction $K^+d \rightarrow dK^+\pi^+\pi^-$ and $K^+d \rightarrow dK^0\pi^+\pi^0$ are also presented. (Diss. Abstr. Int., B)

34569 STUDY OF K-PLUS NEUTRON CHARGE EXCHANGE SCATTERING USING THE REACTION K-PLUS DEUTERON GOES TO PROTON PROTON K-ZERO AT 3.8 GeV/c. Moninger II, William Ringland. Urbana, Ill.; Univ. of Illinois (1971). 147p. University Microfilms Order No. 72-12,302.

Thesis.

Data are presented from 431 examples of the reaction $K^+d \rightarrow K^0pp_s$ at 3.8 GeV/c. The total and differential cross sections are presented. The total cross section is 498 ± 32 μb; the slope of the forward peak in the differential cross section is 4.1 ± .3 (GeV/c)$^{-2}$. The total cross section is compared to cross sections for this reaction at other energies. The value $\sigma(K^+d \rightarrow K^0pp_s) \sim P_{\mathrm{Lab}}^{-2.09\pm.04}$ is found. The differential section for this reaction is compared to the prediction of Rarita and Schwarzschild and to K^-p charge exchange. Total and differential cross sections $K^+n \rightarrow K^0p$ are inferred from the K^+d data. The forward amplitude for $K^+n \rightarrow K^0p$ is found to be predominantly real. (Diss. Abstr. Int., B)

34570 STUDY OF THE DIFFERENTIAL CROSS SECTION OF THE REACTION PI-MINUS PROTON GOES TO OMEGA-ZERO NEUTRON AT 3.65, 4.5, AND 5.5 GeV/c. Russell, Allison Dean. Urbana, Ill.; Univ. of Illinois (1971). 108p. University Microfilms Order No. 72-12,364.

Thesis.

A scintillation counter and optical spark chamber experiment was performed to study the differential cross section for the reaction $\pi^-p \rightarrow \omega^0n$ at 3.65, 4.5 and 5.5 GeV/c. The data show a substantial unnatural parity contribution to the scattering amplitude. The natural parity part of the cross section is not consistent with the predictions of a simple model using Reggeized ρ exchange. (Diss. Abstr. Int., B)

34571 STUDY OF FINAL STATES WITH A $\bar{K}^0$-MESON OR Λ-HYPERON IN K^-d INTERACTIONS AT 3.4 GeV/c. Eckert, Richard Raymond. Lawrence, Kan.; Univ. of Kansas (1971). 176p. University Microfilms Order No. 72-11,742.

Thesis.

From an approximately 100,000 frame exposure of the Argonne National Laboratory deuterium bubble chamber to a 3.4 GeV/c negative kaon beam, an analysis is presented of neutron target and coherent deuteron reactions in which either a $\bar{K}^0$-meson or a Λ-hyperon is produced. Reaction cross sections are compared to data at neighboring energies and found to be consistent with a gradual decrease in cross section as a function of beam momentum. K*(890) and Δ (1238) production are observed to be significant in final states with a $\bar{K}^0$, while the Σ (1385) and ρ (765) or ω (785) resonances are produced extensively in the Λ final states. In general, the resonance production is observed to be very peripheral for the lower multiplicity channels. Where possible, the experimental results are compared to predictions of simple theoretical models of the reactions. (Diss. Abstr. Int., B)

34572 HIGH MULTIPLICITY PION PRODUCTION IN 25 GeV/c PI-MINUS-PROTON COLLISIONS. Elbert, Jerome William. Madison, Wis.; Univ. of Wisconsin (1972). 308p. University Microfilms Order No. 72-9117

Thesis.

An experimental study of high-multiplicity 25-GeV/c pi-minus-proton interactions was performed using the Brookhaven National Laboratory 80-inch liquid-hydrogen bubble chamber. Cross sections for events having each (even) number of tracks from 0 to 16 were measured. A statistical model failed to reproduce the observed multiplicity distributions, even when restricted to events of 6 or more prongs. The average number of neutral pions, $\bar{n}_{\pi^0}$, produced in events having each number of tracks was measured by observation of the $e^+ - e^-$ pairs and electromagnetic showers occurring in the liquid and in a tantalum plate in the bubble chamber. These measurements are in approximate agreement with the usual assumption that ⅓ of the produced pions are neutral. More than ⅓ of the produced pions are neutral in events of low charged particle multiplicity and less than ⅓ are neutral in events of high multiplicity. (TSS)

34573 CHARGED SIGMA PRODUCTION IN K^-d INTERACTIONS NEAR 400 MeV/c. Mapp, James Hartwell. Madison, Wis.; Univ. of Wisconsin (1972). 201p. University Microfilms Order No. 72-9139

Thesis.

A study was made of the charged sigma meson ($\Sigma^\pm$) final states in K^-d interactions with an incident K^- meson beam momentum of 400 and 365 MeV/c. The $\Sigma\pi$ final states were studied and a partial wave analysis performed on both the isotopic spin states I = 0 and I = 1. The low-mass events below $\bar{K}N$ threshold were obtained from the K^- interacting with virtual nucleons in the deuteron. The Y_1^* (1385) resonant state appears as a Breit-Wigner resonant loop in the P_{13} partial wave amplitude while the Y_0^* (1405) resonant state in the S_{01} partial wave does not appear to require a Breit-Wigner resonance. The lack of resonant structure implies a small KN Y_0^* (1405) coupling to virtual nucleons. Scattering lengths for the $\Sigma\pi$ system were also found. The ΣN final states were also studied. The Σ^-n triplet state was found to be weak $a_{1,½} = 0$ as was found in previous experiments. The Σ^-n singlet state was found to have a scattering length of $a_{0,½} = -3.0^{+2.0}_{-1.0}$. The lack of bound state decay modes suggests that the singlet state is not bound ($a < 0$) as had been predicted. The Σ^+n triplet I = ½ state was found to be strong with a scattering length of $a_{1,½} = +2.0 \pm 2.0 + 4.0 \pm 2.0$. The positive value is consistent with a bound state in the Σ^+n state below Σ^+n threshold which decays into Λp. The Σ^+n singlet state was found to be negligible with $a_{0,12} = 0$. (Diss. Abstr. Int., B)

34574 FOUR- AND FIVE-BODY FINAL STATE INTERACTIONS IN π^-p COLLISION AT 7 GeV/c. Johnston, Thomas Francis. Toronto; Univ. of Toronto (1970). National Library of Canada, Ottawa.

Thesis.

Analysis of approximately 330,000 pictures of π^-p interactions at 6.95 GeV/c resulted in 20,000 four- and five-body final states of the types $\pi^-\pi^-\pi^+p$, $\pi^-\pi^-\pi^+\pi^0p$, $\pi^-\pi^-\pi^+\pi^+n$ and $\pi^-\pi^0\pi^0p$. Resonance production, in particular ρ, ω^0 and N^{++}_{*} (1238), is abundant. A detailed analysis of the A_2-meson is presented, giving firm support to the hypothesis that both halves of the A_2 have spin-parity $J^P = 2^+$. However the effects of low statistics and low resolution are such that the A_2 splitting is not an independent observation. Evidence for the g^- (1675 MeV)-meson with a spin-parity $J^P = 3^-$ is also presented. In addition, the use of spin-parity matrix elements for three-pion states is outlined. (Diss. Abstr. Int., B)

34575 K^-d INTERACTIONS AT 4.9 GeV/c. Burdick, B. J.; Carnahan, W. H.; Fickinger, W. J.; (and others) (Case Western Reserve Univ., Cleveland). Nucl. Phys.; B41: No. 1, 45-90 (1972).

Results from a 5.4 events/μb 4.93 GeV/c exposure in the Brookhaven National Laboratory 80 inch bubble chamber are presented. Total and differential cross sections are given for the final states: $\Lambda\pi^-$, $\Sigma^0\pi^-$, $\Lambda\pi^-\pi^0$, $\Lambda\pi^-MM$, $\overline{K}^0\pi^-n$, $\overline{K}^0\pi^-MM$, $K^-\pi^-p$, $\overline{K}^0\pi^-d\pi^0$, $K^-\pi^+\pi^-d$ and $\Lambda\pi^-\overline{K}^0K^0$ (where MM represents missing neutrals). Emphasis is placed on analysis of peripherally produced quasi two-body intermediate states. The channels $\overline{K}^0\pi^-n$ and $\Lambda\pi^-\pi^0$ were compared with a generalized Veneziano model calculation. (auth)

34576 SINGLE PION PRODUCTION IN π^+p INTERACTIONS AT 895, 945, 995, AND 1040 MeV/c. Baker, S. L. (Imperial Coll. of Science and Tech., London): Dornan, P. J.; Gopal, G. P.; (and others). Nucl. Phys.; B41: No. 1, 91-109(May 1972).

Cross sections for pion production processes are presented. For the $\pi^+\pi^0p$ and $\pi^+\pi^+n$ channels resonance fractions, determined using simple models which ignore interference effects, are given and the significance of the observed low peak of the $\Delta(1236)$ is discussed. Strong production of the $\pi\Delta$ intermediate state in P and D wave orbital angular momentum states seems to be required. (auth)

34577 NEW ANALYSIS OF $K\pi$ SCATTERING AS OBSERVED IN $K^+p \rightarrow K^{0+}\ \pi^0\ \Delta^{++}$ FROM 3 TO 13 GeV/c. Bingham, H. H. (CERN, Geneva); Dunwoodie, W. M.; Drijard, D.; (and others). Nucl. Phys.; 41: B No. 1, 1-34(1972).

$K\pi$ scattering is studied in 77,300 bubble chamber events of $K^+p \rightarrow K^+\pi^-\pi^+p$ and 18,800 events of $K^+p \rightarrow K^0\pi^0\pi^+p$ for beam momenta between 2.5 and 12.7 GeV/c. The onshell moments of the angular distribution and the cross sections for $K^+\pi^- \rightarrow K^+\pi^-$, $K^+\pi^- \rightarrow K^0\pi^0$ and $K^+\pi^0 \rightarrow K^0\pi^+$ are obtained by extrapolation to the pion pole. The same procedure applied to the π^+p system correctly reproduces the known π^+p scattering. A $K\pi$ phase shift analysis between threshold and 1.1 GeV yields two solutions for the S wave isospin ½ phase shift ($\delta_0^{1/2}$). One solution gives a slowly increasing $\delta_0^{1/2}$ which approaches about 70° at 1.1 GeV. The other solution superposes on this behavior a relatively narrow ($\lesssim$30 MeV) resonant $\delta_0^{1/2}$ state near 890 MeV. Either case is compatible with a resonance in $\delta_0^{1/2}$ near 895 MeV and with a small, negative $\delta_0^{3/2}$. (auth)

34578 FORMATION OF RESONANT STATES IN $K^-n \rightarrow \pi^0\Sigma^-$ BETWEEN 1850 AND 2160 MeV. Islam, G. S.; Cox, G. F.; Colley, D. C.; Heathcote, F. R. (Univ. of Birmingham, Eng.). Pak. J. Sci. Ind. Res.; 14: No. 4-5, 305-10(Aug-Oct 1971).

Results are presented for a partial-wave analysis of the J = 1 reaction $K^-n \rightarrow \pi^0\Sigma^-$ covering a range of CMS energies from 1850 to 2160 MeV. The events used were obtained from the interactions of the type $Kd \rightarrow \pi^0\Sigma^-\ p_s$. Values of the resonance parameters of the Y_1^* (2030) were determined. In addition, it was found that $F_{5/2}$ amplitude resonates at ~1980 MeV whose parameters differ significantly from Y_1^* (1910) but in better agreement with the new Y_1^* (1940) reported by Barnes et al. (auth)

34579 STUDY OF THE REACTION $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ AT 20 GeV/c. Salzberg, B. M.; Harrison, W. C.; Heyda, D.; (and others) (Harvard Univ., Cambridge, Mass.). Nucl. Phys.; B41: No. 2, 397-437(1972).

Strong production of the $N^{*++}(1236)$, the ρ^0 meson and the f^0 meson is observed in the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ at 20 GeV/c. In addition there is a large unstructured A enhancement in the region (1.0 to 1.4) GeV of the 3π mass spectrum, which decays preferentially through the $(\rho^0\pi^-)$ channel. A prominent A_3 peak is also seen in the 3π system at 1.66 GeV, with evidence for a 3π decay mode in addition to the previously observed $(f^0\pi^-)$ decay mode. In the $(p\pi^-)$ system there is evidence for the production of $N^{*0}(1236)$ and other unresolved low mass isobars. The $(p\pi^+\pi^-)$ system also exhibits a broad unresolved enhancement in the region (1.5 to 1.7) GeV which can largely be explained as a kinematical effect. The Wolf calculation of the one pion exchange model is able to reproduce many of the salient features of the data, in particular for N^{*++}, ρ^0 and f^0 production. The enhancements in the 3π system, however, are better fit by double Regge pole models for $(p\pi^-\rho^0)$ and $(p\pi^-f^0)$ production. A double Regge pole model for $(N^{*++}(1236)\pi^-\pi^-)$ production is also compared with the observed $(p\pi^+\pi^-)$ system, but is unable to adequately describe all the features of the data. (auth)

34580 SPIN–PARITY ANALYSIS OF THE LOW-MASS 3π SYSTEM IN THE REACTION $\pi^+p \rightarrow \pi^+\pi^+\pi^-p$ AT 13.1 GeV/c. Lamsa, J. W.; Ezell, C. R.; Gaidos, J. A.; Willmann, R. B. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; B41: No. 2, 388-96(1972).

A spin-parity analysis of the diffractively produced low-mass 3π system is presented; the results are given as a function of the 3π effective mass. Neither the 3π mass spectrum nor its $J^P = 1^+$ component give evidence for a narrow A_1 resonance (width $\lesssim$200 MeV). The results of the spin-parity decomposition are compared with predictions from a partial wave analysis of the Reggeized Deck amplitude. (auth)

34581 TEMPERATURES IN HIGH-ENERGY PION–PROTON INTERACTIONS. Deutschmann, M.; Graessler, H.; Honecker, R.; (and others) (Technische Hochschule, Aachen). Atomkernenergie; 19: No. 3, 221-4(May 1972).

Energy spectra of negative pions produced in π^+p interactions at beam momenta of 8 and 16 GeV/c were studied by dividing the phase space into regions where a thermal equilibrium of pion energies either is found to occur or not. In the first region which is at right angles to the beam direction and which is typical for the so-called pionization process the temperature of ~114 MeV does not depend on the incident momentum. In the remaining part of phase space, the fragmentation region where pions are produced peripherally, the average particle energy is not constant but increases with the beam momentum. (auth)

34582 REACTION $\pi^+p \rightarrow \rho^+p$ AT 2.67 GeV/c: A STUDY OF ISOSCALAR EXCHANGES. Michael, W.; Gidal, G. (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 22, 1475-9 (29 May 1972).

Results are presented of a study of the reaction $\pi^+p \rightarrow \rho^+p$ at 2.67 GeV/c incident π^+ momentum. The contributions due to given spin-parity exchanges are isolated; and, by combining these results with those of a similar π^- experiment, the $I_t = 0$ component of each series is separated. The ω ($I = 0$, $J^{PG} = 1^{--}$) exchange contribution shows a pronounced dip at $-t = 0.4\ (GeV/c)^2$. Evidence is presented for the exchange of a state of minimum quantum numbers, H ($I = 0$, $J^{PG} = 1^{+-}$). (auth)

34583 MEASUREMENT OF THE REACTION $\pi^-p \rightarrow (p\overline{p})n$ AT 18.8 GeV/c. Grayer, G. (CERN, Geneva); Hyams, B.; Jones, C.; (and others). Phys. Lett.; 39B: No. 4, 563-7(15 May 1972).

A sample of 10 350 $\pi^-p \rightarrow p\overline{p}n$ events with peripherally produced $p\overline{p}$ pairs was observed in a spark chamber experiment. The differential cross section $d\sigma/dt$ and the $p\overline{p}$ decay angular distribution suggest that one-pion exchange dominates the production process. The cross section $\sigma(\pi^-\pi^+ \rightarrow p\overline{p})$, obtained by a pole extrapolation, is compared with $\sigma(p\overline{p} \rightarrow \pi^+\pi^-)$ using detailed balance. (auth)

34584 DETERMINATION OF THE K_s^0 DECAY BRANCHING RATIO. Alitti, J.; Lesquoy, E.; Muller, A. (CEN, Saclay, France). Phys. Lett.; 39B: No. 4, 568-70(15 May 1972).

Using K^0's produced in K^+p interactions at 1.4 GeV/c in hydrogen the branching ratio $(K_s^0 \rightarrow \pi^+\pi^-)/(K_s^0 \rightarrow \pi^0\pi^0)$ was measured. The result 2.22 ± 0.10 is in good agreement with the average of earlier experiments. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 34556, 34700, 34724, and 34734.

34585 (COO-3130-TA-260) DUAL-AMPLITUDE ANALYSIS OF INCLUSIVE DISTRIBUTIONS. Kang, Kyungsik (Brown Univ., Providence, R. I. Dept. of Physics). [1972]. 14p. Dep. NTIS.

A brief summary is given of the dual-amplitude analyses of the inclusive distributions at high energies. (J.F.P.)

34586 GRAPHICAL METHODS OF SPIN ALGEBRAS IN ATOMIC, NUCLEAR, AND PARTICLE PHYSICS. El Baz, E.; Castel, B. Theoretical Physics, a Series of Monographs. Volume 2. New York; Marcel Dekker, Inc. (1972). 439p. $19.50.

The treatment of the graphical method covers the foundations of the method, vector addition coefficients, the generalized vector coupling coefficient, rules governing diagram transformations, the 3nj coefficients, linking different coupling modes, rotation matrices, spherical harmonics, and irreducible tensor operators. Applications are made to nuclear and atomic physics which include the two-body interaction, extraction of the geometrical part of a Feynman diagram, nuclear electromagnetic interactions, coefficients of fraction parentage, and angular distribution and polarization phenomena in nuclear reactions. Other applications are study of direct nuclear reactions, the three-body problem, and the graphical method for SU(3) coupling factors. (J.F.P.)

34587 FINITE-DIMENSIONAL GEL'FAND–YAGLOM EQUATIONS FOR ARBITRARY INTEGRAL SPIN. Amar, V.; Dozzio, U. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan. Univ., Milan). Nuovo Cim.; 9B: No. 1, 53-63(11 May 1972).

A method is given for the construction of Gel'fand–Yaglom equations for integral spin particles with nonzero mass and energy density positive definite. The equations for a particle of spin 3 are explicitly derived. (auth)

34588 STATISTICAL QUANTITIES IN PARTICLE COLLISIONS. Byckling, E.; Sohlo, S.; Suhonen, E. (Univ. of Jyvaeskylae, Finland). Nucl. Phys.; B41: No. 1, 285-98(1972).

Statistical quantities for particle collisions are defined using the analogy between the phase-space integral in multiparticle collisions and that in relativistic quantum statistical mechanics. The analogs of thermodynamic quantities are computed for the uncorrelated jet model. A relativistic derivation for the mass spectrum of hadrons is given and thermodynamic quantities are calculated for a system with this spectrum. (auth)

34589 SCATTERING OF n(gt 2) INCIDENT PARTICLES. Pancheri-Srivastava, G.; Srivastava, Y. (Univ., Rome. CNEN, Frascati, Italy). Lett. Nuovo Cim.; 3: No. 18, 743-6(29 Apr 1972).

The general case of an arbitrary number of incident particles scattering on a target is considered. Some simple formalism is developed for the transition rates. Speculations are made on the feasibility of these experiments using electron and hadron colliding-beam machines. (L.B.S.)

34590 ELEMENTARY PARTICLES. Hughes, I. S. Harmondsworth, Eng.; Penguin (1972). 254p. £2.50.

The subject is dealt with under the headings: particle beams and particle detectors, π mesons and μ mesons, conservation laws, strong, weak and electromagnetic interactions, discovery of the strange particles, the Gell-Mann–Nishijima scheme and conservation of strangeness, spin and parity of the K-mesons and non-conservation of parity in weak interactions, invariance under the CP and T operations, of K^0 mesons and other selection rules for weak decays, strongly decaying resonances, classification of particles: SU(3) and the quark model, relativistic kinematics and phase space, and Clebsch–Gordan coefficients and particle properties. (UK)

34591 MASS QUANTIZATION OF ELEMENTARY PARTICLES. Kumar, N.; Muthanna, M.; Sinha, K. P. (Indian Inst. of Science, Bangalore). Proc. Indian Acad. Sci., Sect. A; 75: No. 2, 57-67 (Feb 1972).

A semi-phenomenological theory of mass quantization is presented, wherein different elementary particles are regarded as excited positive-energy states of a fundamental extensible object. The latter is essentially an elastic continuum which in its quiescent (classical equilibrium) state is believed to be massless and stressless. The classical Hamiltonian describing its oscillations about the equilibrium configuration is constructed by treating the mass-equivalent of the elastic potential energy as the inertial mass occurring in the denominator of the kinetic energy term. Quantization of the resulting variable-mass oscillator is then effected by following the procedure given by Pauli and Podolsky. The energy-mass eigenvalues (m_n) for the above Schrödinger-like equation are given by $(m_n/m_0) = \{1 + [(9/2)^{1/3} (\bar{\lambda}_0/r_c)^{2/3}]p_n^{2/3}]\}$ where $\bar{\lambda}_0$ is the Compton wavelength of the lowest (ground state) eigen mass m_0, r_c is the measure of the linear dimension of the object, and p_n is the nth root of the Bessel function of order $1/3$. In view of their infinite lifetime the electron and the proton are treated as the ground states for the two families of particles with baryon numbers zero and unity respectively. Accordingly, for the two families, m_0 and r_c are chosen to correspond to the electron and the proton. The calculated mass values show striking agreement with the observed values for the two series. (auth)

34592 MAJOR PROBLEMS OF CONTEMPORARY PHYSICS. Segre, E. (Univ. of California, Berkeley). Endeavour; 31: No. 113, 55-9(May 1972).

Although great progress has been made in atomic, nuclear and particle physics in this century some of the most fundamental questions in these fields remain unanswered. Some basic concepts of particle physics are considered and areas of doubt and lack of knowledge, such as the quantization of the electric charge, made evident. (UK)

34593 THREE-DIMENSIONAL QUASI-POTENTIAL-TYPE EQUATIONS FOR TWO SPINOR PARTICLES (MANY-CHANNEL PROBLEM). Natroshvili, K. R.; Khelashvili, A. A. Soobshch. Akad. Nauk. Gruz. SSR; 66: No. 2, 305-8(May 1972). (In Russian).

Three-dimensional equations for two-body many-channel reactions are derived for the case of arbitrary spin. Phase shift analysis with respect to the total angular momentum was carried out. (auth)

Electromagnetic

Refer also to abstracts 34017, 34530, 34691, 34704, and 34711.

34594 TRACE FORMULAS FOR CHARGED PARTICLES IN NONRELATIVISTIC QUANTUM MECHANICS. Yafaev, D. R. (Leningrad State Univ.). Teor. Mat. Fiz.; 11: No. 1, 78-92 (Apr 1972). (In Russian).

The radial Schrödinger operator for charged particles is considered. The set of identities analogous to the well-known trace formulas for the Schrödinger operator with quickly decreasing potential is obtained. It is shown that the trace formula of zeroth order implies the equality of quantum defects of the discrete and continuous spectra. (auth)

34595 FIELD THEORETIC MODELS OF DEEP INELASTIC LEPTON–NUCLEON SCATTERING. Blaha, Stephen. New York; Rockefeller Univ. (1971). 109p. University Microfilms Order No. 72-12,665.

Thesis.

The asymptotic behavior of the inelastic electron-nucleon structure functions is investigated within the framework of ladder models of the virtual Compton amplitude in the limit $|q^2| \rightarrow \infty$ with $\omega = 2q.p/|q^2|$ large and fixed. (q is the electron four-momentum transfer and p the target nucleon momentum.) The leading logarithmic behavior of the ladder diagrams is obtained by Mellin transform techniques. The results are: The structure functions do not scale (i.e., become nontrivial functions of ω) in the neutral vector meson ladder model and the pseudoscalar meson model because of the appearance of factors of ln $|q^2|$. Also the neutrino-nucleon structure functions are found in analogous ladder models, and they exhibit the same nonscaling behavior. In all cases νW_2, W_1 and νW_3 (in the case of neutrino scattering) diverge as $|q^2| \rightarrow \infty$. In a truss bridge diagram model similar to that of Bjorken and Wu νW_2 scales while W_1 does not. To fourth order in the meson-nucleon coupling constant, g, ladder diagrams are the only Compton scattering diagrams contributing to the leading logarithm for each order in g in the neutral vector meson theory and pseudoscalar meson theory. Ladder diagrams with nucleon loops contribute to the leading logarithm in the neutral vector meson theory but do not contribute to the leading logarithm in the pseudoscalar meson theory. The leading part of the Bethe–Salpeter equation for the Compton amplitude in the neutral vector meson ladder model is closely related to Jackiw's Bethe–Salpeter equation for the electromagnetic vertex. (MT^{μ}_{μ} which is the trace of the spin-averaged virtual Compton amplitude is equal to Jackiw's off-mass-shell solution for the vertex where M is the nucleon mass.) (Diss. Abstr. Int., B)

34596 INTRINSIC MOMENTUM COMPUTATION OF A CHARGED PARTICLE IN A MAGNETIC FIELD. Abramson, Harvey D. (McGill Univ., Montreal). J. Comput. Phys.; 9: No. 2, 372-4(Apr 1972).

The example of the given charged particle momentum computation in a magnetic field is that of particle tracks in spark and bubble chamber events. (J.F.P.)

34597 DUAL PARTON MODEL AND APPLICATION TO $e + p \rightarrow e' + X$ AND $e + p \rightarrow e' + A + X$. Lee, Chong Ouk. New York; Yeshiva Univ. (1971). 83p. University Microfilms Order No. 72-11,168.

Thesis.

A model for deep inelastic electroproduction is studied in which the virtual photon is absorbed by individual constituents, i.e., partons of a hadron. The partons are initially identified with the internal lines of complicated Feynman diagrams. It is shown that the absorptive part of the amplitudes for virtual Compton scattering remains unchanged in the Bjorken limit if each of the mass-shell constraints, except the one between two photons, is replaced by a usual Feynman propagator. The contributions of various Feynman diagrams are summed by making a continuum approximation to the planar network of Feynman diagrams, and assuming the average momentum flow on the network is similar to that on the world-sheet of the dual resonance model. Predictions for the structure functions for e + p → e′ + X are made: in particular, they scale in the Bjorken limit. Also the four structure functions for e + p → e′ + A + X in the "Bjorken" limit are constructed and a scaling behavior in the same limit is found. (Diss. Abstr. Int., B)

34598 REGGE MODEL FOR VECTOR MESON PHOTOPRODUCTION. Estabrooks, Penny Gail. Madison, Wis.; Univ. of Wisconsin (1972). 127p. University Microfilms Order No. 72-4271.

Thesis.

Diffractive production of vector mesons from photons ($\gamma p \to V^0 p$) is studied in the Regge pole framework. The differential cross section and density matrix elements are expressed in terms of Reggeized kinematic singularity-free parity-conserving helicity amplitudes, with appropriate threshold and pseudo-threshold relations imposed. It is shown that, to leading order in energy, the density matrix elements have no interference terms between $\tau P = +1$ and $\tau P = -1$ exchanges as a consequence of parity conservation. The helicity structure of the Pomeron coupling at the γV and $\bar{N}N$ vertices is investigated in light of recent $\gamma p \to \rho^0 p$ data. Conservation of s-channel helicity is found to be necessary only at the γV vertex. The data on $\gamma p \to \rho^0 p$ and $\gamma p \to \phi p$ differential cross sections and $\gamma p \to \rho^0 p$ density matrix elements are analyzed in terms of vacuum and P′ Regge exchanges. It is found that the unnatural parity exchange contributions to ω photoproduction conserve t-channel helicity at the $\gamma\omega$ vertex, but that s-channel helicity conservation for the Pomeron may not be valid in this reaction. The data on the $\gamma p \to \omega p$ differential cross sections and density matrices are fit using P′ and A_1 exchanges and broken s-channel helicity conservation for the Pomeron. It is argued that the apparent failure of s-channel helicity conservation in the $\gamma p \to \omega p$ reaction may in fact be due to direct channel resonance effects. (Diss. Abstr. Int., B)

34599 ELECTROMAGNETIC MASS DIFFERENCE OF PIONS IN THE PRESENCE OF SCALAR GRAVITY. Farkas, I.; Pocsik, G. (Roland Eoetvoes Univ., Budapest). Nucl. Phys.; B41: No. 1, 157-65(1972).

The electromagnetic mass difference of pions is calculated in gravity-modified quantum electrodynamics to second order of the electromagnetic interaction. The result is 3.9 MeV which lies 0.7 MeV lower than the experimental value 4.6 MeV. The vierbein description of the gravity is assumed. (auth)

34600 DEEP ELASTIC SCATTERING IN THE PARTON MODEL. Holwerda, M. J.; Van Neerven, W. L.; Van Royen, R. P. (Univ. of Nijmegen, Netherlands). Nucl. Phys.; B41: No. 1, 166-72(1972).

The often suggested connection between the large q^2 behavior of the proton form factor and the large transverse momentum dependence of proton–proton scattering is shown to be absent in the parton model. (auth)

34601 RADIATIVE WIDTH OF THE S_{11} (1550) FROM A STUDY OF η PHOTOPRODUCTION. Deans, S. R. (Univ. of South Florida, Tampa); Jacobs, D. T.; Lyons, P. W.; Hicks, H. R. Particles Nucl.; 3: No. 4, 217-21(Apr 1972).

A phenomenological model is used to make comparisons with the experimental data for the process $\gamma p \to \eta p$ and to calculate the radiative width for the S_{11} (1550) resonant state. $\Gamma_\gamma (S_{11} \to \gamma p) = 0.42 \pm 0.14$ MeV is obtained. In addition, ranges are given for the radiative widths of the S_{11} (1700) and P_{11} (1750) states. (auth)

34602 ASYMMETRY AND LEADING PARTICLES. Shen, M. L. (Tusculum Coll., Greeneville, Tenn. Brown Univ., Providence). Phys. Rev. Lett.; 28: No. 21, 1412-15(22 May 1972).

A remarkable regularity is demonstrated for the asymmetry parameter $\langle \gamma_s / \gamma_c \rangle_a$ of all charged secondaries in multiparticle processes, viz., $\langle \gamma_s / \gamma_c \rangle_a = n_s^{-0.58} g(E_p)$, where n_s and E_p are, respectively, the number of shower particles and the incident energy for a given multiparticle event. A simple derivation of $g(E_p)$ in terms of the emission model is shown and the implications of the results as they relate to the concept of leading particles are discussed. (auth)

34603 CONNECTION BETWEEN THE STRUCTURE FUNCTION OF e + N → e + PHOTON + ANYTHING AND e + N → e + ANYTHING. AN APPLICATION OF FRITZCH–GELL-MANN ALGEBRA. Murtaza, G.; Razmi, M. S. K. (Univ. of Islamabad, Pakistan). Lett. Nuovo Cim.; 3: No. 18, 723-8(29 Apr 1972).

The Fritzch–Gell-Mann algebra is applied to the inclusive electromagnetic process e + N → e + photon + anything in order to examine whether the nonbremsstrahlung diagram can be related to the process e + N → e + anything in kinematical regions. The Fritzch–Gell-Mann algebra leads to relations between the new structure functions and $W_{1,2}$. (L.B.S.)

34604 PROCEEDINGS OF THE 1971 INTERNATIONAL SYMPOSIUM ON ELECTRON AND PHOTON INTERACTIONS AT HIGH ENERGIES. Conference Held at Ithaca, N. Y., August 23–27, 1971. Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell University (1972). 357p. $13.00. (CONF-710816).

Sixteen papers are included; separate abstracts are prepared for twelve. Four papers were previously abstracted for NSA and appeared as CONF-710816-2, -3, -4, and -5. Abstracts of 325 contributed papers are included as an appendix to the proceedings. (L.B.S.)

For abstracts of individual papers see: 34544–34548, 34605–34609, 34711, and 34712.

34605 CURRENTS: WEAK AND ELECTROMAGNETIC. Treiman, S. B. (National Accelerator Lab., Batavia, Ill. Princeton Univ., N. J.). pp 1-11 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

A general discussion is given on the status of the physics of weak currents and the connection between hadron weak and electromagnetic currents. The behavior of these currents under various strong interaction symmetries is also discussed. (L.B.S.)

34606 PRODUCTS OF CURRENTS. Wilson, Kenneth (Cornell Univ., Ithaca, N. Y.). pp 115-45 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

The basic ideas being used to explain the short distance behavior of currents are explained. Section 2 contains some comments on the parton hypothesis and explains the relevance of the short-distance and light-cone behavior of currents to the parton hypothesis. Operator product expansions at short distances are explained in Section 3; applications to $e^+ - e^-$ annihilation, deep inelastic electron scattering, and electromagnetic corrections to strong interactions are described in Section 4. Section 5 reviews the equal-time commutator formulation of the quark parton model. The relation of light cone behavior of currents to deep inelastic scattering is reviewed in Section 6. The light cone formulation of the quark parton model is explained in Section 7. The remaining three sections are devoted to other possible applications of light cone behavior: the Brandt-Preparata theory of vertex functions in Section 8, fixed poles in Compton scattering in Section 9, and μ pair production in p-p collision in Section 10. (L.B.S.)

34607 PHOTOPRODUCTION OF PSEUDOSCALAR MESONS. Wiik, Bjorn (Stanford Univ., Calif.). pp 163-88 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

New data on high-energy photoproduction of pseudoscalar mesons since the Liverpool conference are reviewed. The following topics are discussed: π° photoproduction, η photoproduction, $\gamma p \to \pi^+ n$, $\gamma p \to \pi\Delta$, and $\pi^- p \to \rho^0 n$. Data on photon induced inclusive reactions are discussed under the following topics: multiplicities and topological cross sections; the transverse momentum distribution; scaling and limiting behavior; comparison with hadronic reactions; and asymmetry with polarized photons. (L.B.S.)

34608 NUCLEAR PHOTOPROCESSES AND VECTOR DOMINANCE. Gottfried, Kurt (CERN, Geneva. Cornell Univ., Ithaca, N. Y.). pp 221-45 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High

Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

A review is given of the theoretical and experimental literature on the following topics: the optical model; ρ, ω, and ϕ photoproduction in complex nuclei, and the determination of the $V-\gamma$ coupling constants and VN total cross sections; leptonic decay modes of photoproduced V's; $\rho-\omega$ interference; the optical characteristics of nuclei implied by vector meson dominance; total nuclear cross sections for real and virtual photons; and nuclear photoproduction of pions. (auth)

34609 MODELS FOR HIGH ENERGY PHOTOPRODUCTION AND LOW-Q^2 ELECTROPRODUCTION. Harari, Haim (Weizmann Inst. of Science, Rehovot, Israel). pp 299-317 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

The theoretical highlights of the new data on high energy photoproduction and low-q^2 electroproduction are discussed, emphasizing the close connection between hadron initiated reactions and real and virtual photon initiated processes. (L.B.S.)

34610 SOME REMARKS ON BOSON PAIR CREATION IN ALTERNATING EXTERNAL FIELD. Perelomov, A. M. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett.; 39A: No. 3, 165-6(8 May 1972).

The group-theoretical aspects of the problems of boson pair creation in an alternating external field are discussed. It is shown that the dynamical symmetry group of the problem is the SU(N,N) group, where $N = 2S + 1$, S being the spin of the particle. (auth)

34611 COHESIVE FORCE OF ELECTRON AND NAMBU'S MASS-FORMULA. Ito, Daisuke (Instituto de Fisica Teorica, Sao Paulo, Brazil). Progr. Theor. Phys. (Kyoto); 47: No. 3, 1067-8(Mar 1972).

The possibility of a cohesive force of the electron in a state of stable equilibrium from which small vibrations around the equilibrium position are expected is examined. The implications of Nambu's empirical mass formula for the mass of the first excited state of the electron are discussed. (J.F.P.)

34612 VAVILOV—CHERENKOV EFFECT AND ANOMALOUS DOPPLER EFFECT IN A MEDIUM IN WHICH THE WAVE PHASE VELOCITY EXCEEDS THE VELOCITY OF LIGHT IN A VACUUM. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 62: No. 1, 173-5(Jan 1972). (In Russian).

Attention is drawn to the fact that the Vavilov—Cherenkov effect and anomalous Doppler effect may occur for waves whose phase velocity exceeds the velocity of light in vacuum. (auth)

34613 INVARIANT AMPLITUDES AND DOUBLE DISPERSION RELATIONS FOR ELECTRON—MUON SCATTERING. Van Nieuwenhuizen, P. (CERN, Geneva); Oberholzer, J. Nucl. Phys.; B41: No. 2, 626-42(1972).

For electron-muon scattering, a set of six invariant amplitudes free from kinematical singularities is determined. A simple proof of this freedom is given. Projection operators for this set are constructed. Double dispersion relations using natural subtraction points are derived for the box diagram. (auth)

34614 W_1 AND W_0 PRODUCTION BY COLLIDING e^+e^- BEAMS. Buchl, R. A.; Nigam, B. P. (Arizona State Univ., Tempe). Nucl. Phys.; B41: No. 2, 587-90(1972).

The colliding beam process, $e^+e^- \to W_0^\pm W_1^\pm$, is examined, as occurring by the one-photon process. W_0 is the spin-zero intermediate boson conjectured to exist by Lee. W_1 is the spin-one boson, which is the familiar weak interaction theory intermediate boson. The anomalous magnetic moment of the W_1 is assumed to be zero and the masses of the two bosons are assumed to be related, for example, by $m_0 = \frac{1}{2} m_1$. For $m_1 = 2$ GeV and at $s = 10$ GeV^2, the total cross section for $e^+e^- \to W_0^\pm W_1^\pm$ is about 4×10^{-33} cm^2. (auth)

34615 SCALING BEHAVIOR IN OFF-SHELL PHOTON—PHOTON SCATTERING. Walsh, T. F. (Univ., Hamburg); Zerwas, P. Nucl. Phys.; B41: No. 2, 551-6(1972).

Some of the theoretical questions which can be studied in the reaction $e + e \to e + e$ + hadrons where the electrons are scattered with large momentum transfer are investigated. The even charge conjugation part of this reaction is determined by the off-mass shell behavior of the amplitude $\gamma^* + \gamma^* \to$ hadrons. At fixed hadron mass, there exists a scaling relation for this amplitude in terms of the virtual photon masses. When the hadron mass becomes large, parton models and bilocal algebras yield definite predictions for the absorptive part of the forward virtual photon-photon scattering amplitude. The colliding beam cross sections which result are of order 10^{-36} cm^2. (auth)

34616 UNIFIED WEAK AND ELECTROMAGNETIC INTERACTIONS WITHOUT NEUTRAL CURRENTS. George, Howard; Glashow, Sheldon L. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 28: No. 22, 1494-7(29 May 1972).

Unified models of weak and electromagnetic interactions are constructed using just three gauge fields which correspond to the intermediate vector boson and the photon. These models may be renormalizable and do not predict processes involving neutral lepton currents. (auth)

34617 NONPERTURBATIVE EVALUATION OF THE ANOMALIES IN LOW-ENERGY THEOREM. Crewther, R. J. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 28: No. 21, 1421-4(22 May 1972).
1972).

It is shown that the anomalous constant S associated with the soft $\pi^0 \to 2\gamma$ decay amplitude is determined by a product of high-energy electroproduction and annihilation cross sections. A similar result holds for the coupling of the trace of the stress-energy tensor to photons. Wilson's theory of broken scale invariance is assumed. It is observed that the Fritzsch—Gell-Mann algebra of bilocal operators uniquely specifies disconnected contributions, and, in particular, implies $S = \frac{1}{6}$, the quark field-theoretic value. (auth)

34618 PSEUDOVECTOR COUPLING AND CHARGED-PION ELECTROPRODUCTION. Glueck, M. (Univ. Marburg, Ger.). Phys. Rev. Lett.; 28: No. 22, 1486-7(29 May 1972).

It is shown that pion electroproduction experiments can, in principle, distinguish between a pseudoscalar and a pseudovector pion-nucleon coupling. It is further shown that this is not the case for the corresponding photoproduction experiments. (auth)

34619 PAIRED SPECTRA OF PARTICLES IN COLLIDING BEAMS AT HIGH ENERGIES. Ter-Martirosyan, K. A.; Shabel'skii, Yu. M. JETP Lett. (USSR) (Engl. Transl.); 15: No. 3, 113-15(5 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 3, 164-7(5 Feb 1972).

The total cross sections for the production of two particles in colliding beams analogous to the total cross sections for particle production in inclusive interactions is studied using Reggeon scattering theory. (J.F.P.)

34620 HIGH-ENERGY ASYMPTOTIC FORM OF SCATTERING AMPLITUDES AND VERTEX FUNCTIONS. Khalfin, L. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 4, 149-51(20 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 4, 215-18(20 Feb 1972).

Using a previous representation of the high-energy asymptotic form the determination of this asymptotic form from the space-like structure not on the light cone, the conditions under which this takes place, and experimental tests for verifying these conditions are treated. As an example the investigation of the asymptotic form of the imaginary part of the amplitude for forward scattering of a virtual γ quantum with mass q^2 and energy q_0 by a nucleon is given. (J.F.P.)

34621 INELASTIC CONTRIBUTIONS TO ELECTROMAGNETIC FORM FACTOR OF THE PION. Baier, V. N.; Fadin, V. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 4, 151-5(20 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 4, 219-24(20 Feb 1972).

The inelastic contributions to the unitarity relation for the pion electromagnetic form factor, of which the increase was measured previously in the production of $\pi^+ - \pi^-$ pairs in $e^+ + e^-$ interactions in colliding beams, is discussed. This increase is explained by the photon going over to multihadron states which are then transformed into the pion pair. The multiparticle intermediates states are significant as inelastic contributions to the increase. (J.F.P.)

34622 TOTAL CROSS SECTIONS FOR THE PRODUCTION OF ELECTRONIC AND MUONIC PAIRS IN COLLIDING ELECTRON BEAMS. Kuraev, E. A.; Lipatov, L. N. (Leningrad Inst. of Nuclear Physics). JETP Lett. (USSR) (Engl. Transl.); 15: No. 4, 159-63(20 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 4, 229-32(20 Feb 1972).

The calculated contribution to the total cross sections accurate to terms $\sim \alpha^2 r_0^2$ from given diagrams is presented for $e^+ - e^-$ and $\mu^+ - \mu^-$ pair and hadron production in e + e and $e^+ + e^-$ interactions in colliding beams. (J.F.P.)

34623 GROUP THEORY AND THE COULOMB PROBLEM. Englefield, M. J. New York; John Wiley and Sons, Inc. (1972). 126p. $11.95.

The treatment covers Lie algebras and groups, angular momentum theory, energy eigenvalues and eigenstates, momentum space, special coordinate systems, and noninvariance algebras and groups. (J.F.P.)

34624 QUANTUM THEORY OF VAVILOV–CHERENKOV RADIATION OF DIRAC PARTICLES IN A TRANSPARENT UNIAXIAL CRYSTAL. Kukanov, A. B.; Orisa, B. D. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 100-4(1971). (In Russian).

The quantum theory of Vavilov–Cherenkov radiation of Dirac particles in a transparent uniaxial crystal was investigated. The special cases were considered for a particle originally moving along the crystal optic axis and perpendicular to it. (tr-auth)

34625 FINITE ELECTROMAGNETIC MASSES. Palmer, D. (Univ. of Rochester, N. Y.). Phys. Lett.; 39B: No. 4, 517-20(15 May 1972).

A null-plane current commutator algebra, abstracted from a fermion theory, is shown to satisfy the Pagels condition for finite electromagnetic self-masses of hadrons. (auth)

34626 SEPARATION OF σ_S AND σ_T IN THE REGION OF THE Δ (1236) RESONANCE AND DETERMINATION OF THE MAGNETIC DIPOLE TRANSITION FORM FACTOR. Baetzner, K.; Beck, U.; Becks, K. H.; (and others) (Univ., Bonn). Phys. Lett.; 39B: No. 4, 575-8(15 May 1972).

The longitudinal and transverse cross sections σ_S and σ_T are evaluated from measurements of inelastic ep scattering at scattering angles ranging from 20° to 81°. The magnetic dipole transition form factor G_M^* is determined and the reliability of the determination is discussed. (auth)

34627 NON-SCALING CONTRIBUTIONS TO THE DEEP INELASTIC e–p SCATTERING AND BILOCAL ALGEBRA. Mahanthappa, K. T.; Yao, Tsu (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 39B: No. 4, 549-52(15 May 1972).

Non-scaling corrections to the structure functions of inelastic e-p scattering are obtained under the assumption that both leading and non-leading light cone ($x^2 \rightarrow 0$) singularities give rise to the Fritzsch–Gell–Mann algebra of bilocal operators. These functions are expressible in terms of a single function thus enabling a sum rule to be written between them. Thus the verification of the sum rule provides a test of the assumption; the failure of the sum rule does not invalidate the Fritzsch–Gell–Mann algebra for leading light cone singularities alone. (auth)

34628 PARTON MODEL OF WEINBERG'S THEORY OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Budny, R. (Oxford Univ.). Phys. Lett.; 39B: No. 4, 553-8(15 May 1972).

Parton model predictions for deep inelastic lepton scattering on nucleons in Weinberg's theory are presented. Bounds are given for the neutrino and antineutrino cross section and for the neutral cross section $\nu + N \rightarrow \nu + X$. (auth)

34629 FINITE-DISPERSION-RELATION RESTRICTIONS ON INTERFERING MESON MODELS. Lassila, K. E.; Young, B. L. (Iowa State Univ., Ames). Phys. Rev. Lett.; 28: No. 22, 1491-3 (29 May 1972).

Using the finite-dispersion-relation method for treating three-body decays, it is found that bounds can be placed upon the coupling strengths of two interfering resonances. A special result is that two narrow interfering coherent (or incoherent) resonances for the A_2 meson fail to satisfy a finite-dispersion-relation, finite-energy sum rule for coupling strengths (widths) which follows from the $\eta \rightarrow \pi^+\pi^-\gamma$ decay rate. This appears to be the first evidence independent of mass distributions indicating that one of the tabulated descriptions of the A_2 is wrong. (auth)

Weak

Refer also to abstract 34556.

34630 NONLEPTONIC HYPERON DECAYS AND UR-CITON SCHEME. Ishida, Shin; Nakamura, Katsuya; Oda, Masuho (Nihon Univ., Tokyo. Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 47: No. 1, 304-16(Jan 1972).

Non-leptonic hyperon decays are investigated using the ur-citon scheme, which was proposed recently for unified and relativistic treatment of hadrons. In the case "four-ur-citon interaction" with V–A type the octet dominance is rigorously derived and it is shown that the theory with only one adjustable parameter reproduces the qualitative behavior of experiment except for the P-wave decay of Ξ. The other interesting case of the two-ur-citon interaction is also investigated. (auth)

34631 K_{l4} DECAY FORM FACTORS IN THE BROKEN SU(3) × SU(3) MODEL. Bose, Subir; Narayanaswamy, P. (Southern Illinois Univ., Carbondale. Illinois Univ., Edwardsville). Progr. Theor. Phys. (Kyoto); 47: No. 1, 237-45(Jan 1972).

The K_{l4} form factors are calculated in the $(3^*,3) + (3,3^*)$ model of broken chiral SU(3) × SU(3), without invoking any perturbative treatment of the symmetry breaking. The results are compared with other theoretical calculations and with available experimental data. (auth)

34632 THEORY OF WEAK INTERACTIONS IN PARTICLE PHYSICS. Bailin, D. (Univ. of Sussex, Brighton, Eng.). Rep. Progr. Phys.; 34: No. 6, 491-599(1971).

A summary of the major theoretical ideas which have dominated the field of weak interactions during the last seven years is given. It is assumed that the Hamiltonian responsible for weak interactions has the traditional CP-invariant current–current form and that it is a good approximation to work to first order in the weak coupling constant. A quantitative comparison of the resulting theoretical predictions with the experimental data is made. Widespread consistency is found, although the theory lacks predictive power in certain areas where the data seem to be quite simple. The serious inadequacies of the theory are exposed when higher-order terms in the perturbation series are considered; the theory predicts that these diverge unrenormalizably while the data indicate that they are very small. The experimental data on CP-invariant processes are reviewed and the models which have been advanced to explain this phenomenon are discussed. (UK)

34633 REAL AND VIRTUAL PHOTONS IN WEAK LEPTONIC PROCESSES AT HIGH ENERGIES. Dolgov, A. D.; Okun, L. B.; Zakharov, V. I. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys.; B41: No. 1, 197-214(1972).

Weak-electromagnetic processes in colliding $ee(e\mu,\mu\mu)$ beams at high energy are discussed ($E \approx 2 \times 200$ GeV). Radiative and higher order weak corrections to the amplitude of reaction $e^+e^- \rightarrow \nu\bar{\nu}\gamma$ are considered. The interference between weak and electromagnetic amplitudes of e^+e^- scattering and $e^+e^- \rightarrow \mu^+\mu^-$ annihilation is calculated. The formulas obtained are applicable also to the muon induced reactions. The logarithmic terms in radiative corrections to cross sections of the above processes are calculated. The corrections to the weak amplitudes due to the hadron contribution are discussed. (auth)

34634 NEUTRINOS OF NONZERO REST MASS. Pakvasa, Sandip; Tennakone, Kirthi (Univ. of Hawaii, Honolulu). Phys. Rev. Lett.; 28: No. 21, 1415-18(22 May 1972).

Some implications of nonzero rest masses and finite lifetimes for neutrinos are considered. (auth)

34635 LEPTON AND HADRON CURRENTS IN $O_{4\ 2}$ CURRENT ALGEBRA. Animalu, A. O. E. (Drexel Univ., Philadelphia). Lett. Nuovo Cim.; 3: No. 18, 729-33(29 Apr 1972).

A possible relation between leptons and spin-½ quarks is suggested based on 0(4,2) current algebra. (L.B.S.)

34636 NONLOCAL HAMILTONIAN AND RADIATIVE-MUON CAPTURE. Christillin, P. (Univ., Pisa, Italy. Scuola Normale Superiore, Pisa, Italy); Rosa-Clot, M. Lett. Nuovo Cim.; 4: No. 1, 1-4(6 May 1972).

The amplitude for the diagrams corresponding to the process $\mu^- + p \rightarrow \gamma + \nu + n$ in configuration space, where the usual V–A pointlike Hamiltonian which describes the μ capture process takes in a different point than the γ emission vertex, is examined. Comments are made on the validity of this approach. (L.B.S.)

34637 CALCULATION OF THE K_{l4} FORM FACTORS IN THE ONE SOFT PION FORMALISM. Rodrigues, W. A., Jr. (Univ. Tourin). Atti Accad. Sci. Torino. I. Cl. Sci. Fis., Mat. Natur.; 106: No. 2, 173-80(Mar–Apr 1972).

Relations between the K_{l4} decay form factors and those for the K_{l3} decay are derived in a simple way and without ambiguities using the one soft pion formalism. The results agree with those found with the more complex double soft pion formalism. (auth)

34638 QUASI-ELASTIC NEUTRINO REACTION IN DEUTERIUM IN THE FORWARD DIRECTION. Bernabeu, J. (CERN, Geneva). Phys. Lett.; 39B: No. 3, 313-18(1 May 1972).

The forward cross section of the reaction $\nu + d \rightarrow \mu^- + p + p$ is studied under different assumptions. It is shown that a value $E^{-2} (d\sigma/d\Omega) \approx 0.27 \times 10^{-38}$ cm^2/sr GeV^2 is expected independent of the incident neutrino spectrum shape. Relativistic effects and one-pion exchange contributions were estimated. (auth)

Strong (General)

Refer also to abstract 34693.

34639 (NP–19310) POLARIZATION IN HIGH-ENERGY SCATTERING AND ITS PHENOMENOLOGICAL INTERPRETATION. Sanguinetti, G. (European Organization for Nuclear Research, Geneva (Switzerland)). 12 Apr 1972. 216p. Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Scuola Normale Superiore, Pisa, Italy.

The CERN experiment on polarization and differential cross sections for hadron interactions with protons is briefly described. The helicity formalism of elastic scattering, the Reggeization of the helicity amplitudes in the t- and s-channels respectively, the method of generating cuts by means of convolution products of Regge poles, and a detailed analysis of high-energy hadron scattering in the framework of such convolution models are treated. (J.F.P.)

34640 HIGH-ORDER PLANAR FEYNMAN DIAGRAM MODEL FOR HADRONS AND COMPARISON WITH EXPERIMENTS ON DEEP-INELASTIC ELECTRON–NUCLEON SCATTERING. Kraemmer, A. B. (Univ. of Copenhagen); Nielsen, H. B. Nucl. Phys.; B41: No. 1, 173-96(1972).

A short review is given of the high-order planar Feynman diagram model for hadrons and the corresponding analog electrical network model. The model is based on the assumption that the important Feynman diagrams have a surface-like structure, and a density (of vertices, say) on such a surface is defined for each high-order diagram. It is then argued that the average density for an important diagram presumably is invariant under conformal transformations of the surface. From the electrical analog model it is also found that the partons existing at a given moment are those with propagators crossing an equipotential curve in the diagram. (By the expression partons it is meant that the particles are connected to the propagators.) In this way the distribution of parton momenta is found for a free particle with high energy. This distribution is connected to the structure functions νW_2 for deep-inelastic e-p and e-n scattering. By comparing with experiments parameters describing the distribution of densities for the most important diagrams and the "average squared charge" of the partons are then found. Finally, some remarks are made about the significance of the density of diagrams found. (auth)

34641 WHAT IS THE STRANGENESS OF THE NUCLEON. MacGregor, Malcolm H. (Univ. of California, Livermore). Particles Nucl.; 3: No. 4, 173-82(Apr 1972).

It is known from the observance of Y* resonances and the nonobservance of Z* resonances that our present understanding of the strangeness quantum number S is in some manner incomplete. The recent measurement of the $\bar{p}n$ bound state at Syracuse has heightened this experimental difficulty. By devising a simple model for reproducing meson and baryon resonances, a clear-cut empirical relationship is established between binding energies and strangeness quantum numbers. This relationship can be observed directly in the experimental data. From the experimental binding energy systematics, and also from the systematics of the model, it seems clear that the nucleon should be assigned an invariant "nucleon strangeness" of +1. (auth)

34642 CURRENTS AND GREEN'S FUNCTIONS FOR DUAL MODELS. I. Neveu, A. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Scherk, J. Nucl. Phys.; B41: No. 2, 365-87(1972).

In dual models with unit intercept, it is shown that it is possible to explicitly construct currents and/or Green's functions in a way consistent with factorization in the original Hilbert space of physical particle states. In contrast with previous attempts, amplitudes involving more than one current or off-shell particle satisfy that consistency and have only correctly located singularities. It is proved in a few particular cases that the currents and Green's functions thus defined satisfy the conservation rules expected by analogy with similar problems of quantum field theories. The full conformal invariance of dual models with unit intercept is particularly useful for this approach. (auth)

34643 MULTIPERIPHERAL MODELS WITH CHARGED PARTICLES. Amann, R. F. (Syracuse Univ., N. Y.). Nucl. Phys.; B41: No. 2, 605-25(1972).

Techniques are developed to allow the inclusion of many particles with differing quantum numbers in the multiperipheral chain. Within the Chew–Pignotti multi-Regge model these techniques are applied to allow the inclusion of charge in the model. Two proposed models for the isospin structure of the chain, repeated isovector exchange and alternating isoscalar-isovector exchange are discussed; secondary intercepts, charged particle multiplicities, rapidity distributions for charged particles and cross sections for the production of charged prongs are calculated. One immediate result is that an isovector chain predicts that an incoming proton will emerge as a neutron two-thirds of the time (compared to the observed one-third); any realistic model must include isoscalar exchanges in the chain. It is suggested that, if the Pomeranchukon is generated by a simple subset of the available exchanges, then inclusive experiments should spotlight those Regge poles generated simultaneously with it. The utilization of charge correlations to explore this possibility is discussed. (auth)

34644 TESTS OF HIGH-ENERGY MODELS BY TWO-PARTICLE ANALYSES. Hwa, Rudolph C. (Univ. of Oregon, Eugene). Phys. Rev. Lett.; 28: No. 22, 1487-90(29 May 1972).

Two-particle distribution functions are calculated in the diffractive-excitation model and compared with those of the multiperipheral model. Optimum regions for differentiating the predictions of the models are indicated. Decisive, yet feasible, experimental tests are suggested. (auth)

34645 POSSIBLE EXISTENCE OF HADRON ISOMERS. Pontecorvo, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 39B: No. 3, 346-8(1 May 1972).

The possible existence of hadron isomers is discussed using the analogy of nuclear isomers. The hadron isomers are defined as large spin states having relatively low excitation and decaying by pion or photon emission. The possible experimental search for these isomers is considered. It is pointed out that the search must be made by investigating the hadron isomer decay properties. (J.F.P.)

34646 PARAMETRIZATION OF THE COULOMB INTERFERENCE. Hayot, F.; Itzykson, C. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 39B: No. 4, 521-5(15 May 1972).

Within the framework of the eikonal approximation, the expression for the phase difference between the real Coulomb and the strong interaction amplitudes is derived in a simple manner, the latter being parametrized in a definite way. Moreover a formula is given for large momentum transfer corrections to that expression. (auth)

Strong (Baryon No. = 0)

34647 (NP–19311) FEATURES OF DUAL PHENOMENOLOGY OF THREE PARTICLE FINAL STATES. Raitio, Risto O. (Helsinki Univ. (Finland). Dept. of Nuclear Physics). 6 Mar 1972. 18p. Dep. NTIS (U. S. Sales Only).

Thesis.

A review is given of dual phenomenology in $\bar{p}n \rightarrow \pi^+\pi^-\pi^-$ at rest, six channels of the system $\pi K\bar{K}N\bar{N}$, and diffraction dissociation. The theoretical basis of the successful description of data is discussed. (Finland)

34648 CONSTRAINTS ON PI–PI PARTIAL WAVE AMPLITUDES BELOW THRESHOLD, FROM CROSSING SYMMETRY, POSITIVITY AND ANALYTICITY. Griss, Martin Lewis. Urbana, Ill.; Univ. of Illinois (1971). 155p. University Microfilms Order No. 72-12,182.

Thesis.

"Geometrical" inequalities similar to those of Martin for the partial waves $f_l(s)$ of the $\pi^0 - \pi^0$ amplitude in the Mandelstam triangle are derived; these involve only a finite number of partial waves, and follow from positivity and analyticity alone. These, and "tighter" positivity-analyticity inequalities given by Yndurain, are used to derive sets of inequalities involving only a finite number of the Balachandran double partial waves, a_{nl}. Crossing symmetry is introduced by re-expressing these inequalities in terms of Roskies' crossing symmetric parameterization. Using theorems on moment problems, the "best" inequalities for any value of $\sigma = l + n$ are discussed, and the result is expressed as an allowed region of the otherwise-unrestricted parameter space. The $\sigma = 4$, and $\sigma = 5$ "best" inequalities are explicitly calculated, and compared with results previously given by Roskies for the case of $\sigma = 4$. New inequalities relating the partial wave amplitudes $f_l(s)$ and their derivatives $f_{l'}'(s)$ are derived, valid for all $l \geq 2$, and all $0 \leq s \leq 1$. They are combined into the general analysis and compared with similar conditions. The moment approach is used to examine the nature of the inequalities resulting from an alternative method due to Roskies, and to Piguet and Wanders. The advantages, and disadvantages, of this approach are discussed. Finally, applications are discussed to show the constraint that is present in these inequalities. The extension of the method to the case of the $\pi - \pi$ amplitudes with isospin is given. (Diss. Abstr. Int., B)

34649 FACTORIZABLE DUAL MODEL OF PIONS BASED ON A COUPLING OF DUAL SPIN FIELDS WITH $J_s = -\frac{1}{2}$ AND $J_s = -1$. Nickle, H. H. (Southern Illinois Univ., Carbondale). Nucl. Phys.; B41: No. 1, 215-25(1972).

As an example of the group theoretical approach to the construction of new dual resonance models, a model is examined in which the pion trajectory lies $\frac{3}{2}$ units below the Pomeranchuk trajectory, and $\frac{1}{2}$ unit below the ρ trajectory. The model is based on constructing the pion N point function out of the vertex $V_\pi(k,z) = :V_0(k,z)\psi(z) H(z):$, where $V_0(k,z)$ is the conventional Veneziano vertex, and $\psi(z)$ and $H(z)$ transform as $J_S = -\frac{1}{2}$ and $J_S = -1$, respectively, under SU(1,1). An explicit expression is obtained for the four point function, and certain general properties of the model are discussed. (auth)

34650 PHENOMENOLOGICAL J-PLANE SINGULARITIES OF $\pi\pi \rightarrow N\bar{N}$ AMPLITUDES AT T = O. Pietarinen, Esko (NORDITA, Copenhagen). Nucl. Phys.; B 41: No. 1, 110-24(1972).

The Mellin transforms of the imaginary parts of the πN forward amplitudes are computed from the experimental total cross sections. An analytic continuation of these transforms is performed to determine the phenomenological J-plane singularities at $t = 0$. The continuation supports the J-plane analyticity assumption in the case $I = 0$. A generalization of the method to non-forward t-values is indicated. The effective Regge cut is found to be small in $I = 1$ amplitudes. (auth)

34651 DIRECT EMISSION IN $K^\pm \rightarrow \pi^\pm\pi^0\gamma$. Barshay, Saul; Hvegholm, Jens (Univ. of Copenhagen). Phys. Rev. Lett.; 28: No. 21, 1409-11(22 May 1972).

The results of a calculation of a part of the direct-emission amplitude in $K^\pm \rightarrow \pi^\pm\pi^0\gamma$ are presented for which an unambiguous, finite, gauge-invariant expression is obtainable in terms of known parameters. The amplitude produces a small distortion of the Dalitz plot through its destructive interference with the bremsstrahlung amplitude. (auth)

34652 QUARK MODEL FOR ANTIPROTON–NUCLEON ANNIHILATIONS INTO TWO PSEUDOSCALAR MESONS. Chand, Ramesh (Univ. of Texas, Austin. Himachal Pradesh Univ., Simla, India). Particles Nucl.; 3: No. 4, 183-93(Apr 1972).

In an SU(3) quark model, the at rest annihilations $\bar{p}N \rightarrow PP$ are investigated. It is assumed that the physical baryon octet contained in the direct product $3 \otimes 3 \otimes 3$ is given by $8(\text{physical}) = 8' \cos\theta + 8 \sin\theta$, where the baryon octets 8 and 8′ arise from $3 \otimes 3$ and $3 \otimes 6$ respectively. It is found that the value $\theta = 20°$, which explains the data on a) high-energy meson-baryon scattering, b) high-energy photoproduction of mesons, and c) $\bar{p}N \rightarrow PV$ annihilations at rest also explains the available data on $\bar{p}N \rightarrow PP$ reactions. For instance, it is found that for $\theta = 20°$, i) $R(K_1K_2)/R(K^+K^-) = 0.41$, and ii) $R(K^+K^-)/R(\pi^+\pi^-) = 0.34$, which are in good agreement with the experimental data. (auth)

34653 HELICITY AMPLITUDES FOR ANTIBARYON–BARYON SCATTERING. II. Weiner, Richard M. (Indiana Univ., Bloomington). Particles Nucl.; 3: No. 4, 194-216(Apr 1972).

The expressions for helicity amplitudes for the reactions $\bar{p}p \rightarrow \bar{N}N$, $\bar{p}p \rightarrow \bar{\Sigma}^+\Sigma^+$, $\bar{p}p \rightarrow \bar{\Sigma}^-\Sigma^-$, $\bar{p}p \rightarrow \bar{\Xi}^0\Xi^0$, and $\bar{p}p \rightarrow \bar{\Xi}^-\Xi^-$ are given in terms of quark helicity amplitudes. (auth)

34654 IMPROVED CONSTRAINTS ON THE $\pi^0\pi^0$ S-WAVE AMPLITUDE. Grassberger, P. (Univ., Bonn). Nucl. Phys.; B41: No. 2, 474-84(1972).

Constraints on the $\pi^0\pi^0$ S-wave derived recently by Yen and Roskies are strengthened by taking into account the boundedness of the absorptive parts of the partial waves. (auth)

34655 EPSILON PRODUCTION IN A GEOMETRICAL APPROACH. Garcia Canal, C. A. (Univ. Nacional, La Plata); Ferro Fontan, C.; Violini, G. Lett. Nuovo Cim.; 3: No. 15, 616-18(8 Apr 1972).

It is quantitatively shown that dual predictions for ϵ production are in agreement with the experimental data. The spin-flip amplitude for the differential cross section is evaluated using the Harari model. (J.F.P.)

34656 NATURE OF SHARP CHANGES OF $\langle Y_1^0 \rangle$ IN $\pi\pi$ AND $K\pi$ SCATTERINGS. Fujii, Y. (Tokyo Univ.). Phys. Lett.; 39B: No. 4, 539-40(15 May 1972).

It is shown that Odorico's interpretation of the observed sharp changes of the moment $\langle Y_1^0 \rangle$ in $\pi\pi$ and $K\pi$ scatterings is not supported by numerical fits of the data. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 34581.

34657 (ITF–71–92–E) REPRESENTATION OF THE PARTIAL AMPLITUDES BY POWER MOMENTS AND ITS PROPERTIES. Yatsun, V. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 24p. Dep. NTIS (U. S. Sales Only).

Three kinds of algebraic relations for the partial amplitudes, which follow from the Froissart–Gribov formula with nondecreasing distribution function, are derived. The purpose of the work is to represent the partial amplitude by power moments and to use some properties of orthogonal polynomials constructed from these moments. The results of the work are directly applied for the analysis of an elastic particle scattering in nonphysical region of energies when the spin is taken into account. (auth)

34658 (NP–19312) ENERGY DEPENDENCE OF CROSS SECTIONS FOR REACTIONS PRODUCING PIONS IN A SIMPLE MULTIPERIPHERAL MODEL. Pirilae, P. (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics). Jan 1972. 17p. Dep. NTIS (U. S. Sales Only).

The energy dependence of the cross sections for pion producing channels in pp and πp collisions was compared with the prediction of a simple multiperipheral model with exponential dependence on momentum transfers t_i. A reasonable agreement has been found in most of the channels studied. (Finland)

34659 KINEMATICAL SINGULARITIES. I. Leo, R. A.; Minguzzi, A. (Univ., Lecce, Italy). Nuovo Cim.; 9A: No. 1, 28-36(1 May 1972).

A method to deal with the kinematic singularities present in any decomposition of the scattering matrix is presented, with applications to $\pi - N$ and $\pi - \gamma$ elastic scattering. (auth)

34660 INVESTIGATION OF SPIN EFFECTS AT HIGH ENERGY IN QUASIPOTENTIAL APPROACH. Garsevanishvili, V. R.; Goloskokov, S. V.; Matveev, V. A.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 11: No. 1, 37-43(Apr 1972).

Meson-nucleon scattering at high energy is considered in the framework of quasi-potential approach. The representation of the eikonal type for the scattering amplitude is obtained. The corrections of the order $1/p$ with respect to main contributions are calculated. (auth)

34661 K^-–NUCLEUS INTERACTION AND ITS INTERPRETATION. Koch, Justus H.; Sternheim, Morton M. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 28: No. 16, 1061-3 (17 Apr 1972).

Optical-model analysis of x-ray transitions in K-mesic atoms gives an "effective" $\bar{K} - N$ scattering length $\bar{a} = [(0.44 \pm 0.04) + (0.83 \pm 0.07)i]$ F. The large change in $\mathrm{Re}\,\bar{a}$ from the free value is explained by assuming additivity of the $\bar{K}N$ potentials. (auth)

34662 s-CHANNEL HELICITY CONSERVATION IN ABFST MULTIPERIPHERAL MODEL. Islam, S. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B41: No. 1, 226-36 (1972).

The validity and consistency of the hypothesis of asymptotic conservation of s-channel helicity for pomeron (P) exchange in πN scattering is considered in the context of ABFST multiperipheral model. The hypothesis of flip dominance for asymptotic ρ-exchange is also considered. Both the hypotheses are found to be consistent to a good approximation with the model. (auth)

34663 STATIC MODEL, AN EXOTIC RESONANCE AND THE REAL WORLD. Lyth, D. H.; York, M. J. (Univ. of Lancaster, Eng.). Nucl. Phys.; B41: No. 1, 237-71(1972).

Possible improvements to the highly successful static model for πN and $\pi\Delta$ elastic scattering are considered. Resonances are included in other than p-waves, and a more precise analysis of the constraints implied by unitarity is given. In particular, the evidence for an exotic I = J = $^5\!/_2$ isobar predicted by the old static model is assessed. Resonance saturated fixed-t dispersion relations are used, assuming s-channel helicity conservation to eliminate subtraction parameters. All sum rules (including new sum rules following from helicity conservation) were examined as a check on the dynamical input. (auth)

34664 PERIPHERAL PARTIAL WAVES IN PION–NUCLEON SCATTERING FROM TWO PION EXCHANGE. Alcock, J. W.; Cottingham, W. N. (Univ. of Bristol, Eng.). Nucl. Phys.; B41: No. 1, 141-9(1972).

A detailed and critical calculation is presented of the partial-wave amplitudes with large angular momentum in pion-proton scattering up to a lab momentum of 3 GeV/c. (auth)

34665 STATISTICAL THEORY OF A HIGH TEMPERATURE SYSTEM CONTAINING EXCITED PARTICLES. Tomimatsu, Akira; Sato, Humitaka (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 3, 819-31(Mar 1972).

Applying the S-matrix formalism of statistical mechanics to the resonance scattering, the abundance of excited particles is investigated. In the case of the boson-fermion system such as the pion-nucleon system, the pion density in an excited state is found to be suppressed by the degeneracy of nucleons in contrast to the independent particle assumption for excited state. In the case of the fermion-fermion system, Bose-condensation of excited particles is found to occur above some critical density, at which the sum of the chemical potentials equals to the mass of the excited particle. (auth)

34666 UNITARIZED FINITE ENERGY SUM RULES AND THEIR APPLICATION TO πN-CHARGE EXCHANGE. Schrempp, F. (Univ., Hamburg. DESY, Hamburg). Nucl. Phys.; B41: No. 2, 557-86(1972).

The problem of "unitarizing" finite energy sum rules (FESR) by the inclusion of Regge cuts is investigated. Instead of considering Regge cuts in FESR for the full scattering amplitude T_{fi}, new FESR are proposed for that part of T_{fi}, which has just pure Regge pole asymptotic behavior if the Regge cuts are included in T_{fi}. The Regge cuts in the high-energy region are evaluated according to the "weak-cut" version of the Reggeized K-matrix model. The new FESR then look like the conventional ones, however, with T_{fi} replaced by the corresponding two-particle K-matrix element. With these K-matrix FESR the serious difficulties arising in conventional approaches to the problem disappear. With the new K-matrix FESR a detailed analysis of πN-charge exchange is performed. The K-matrix FESR turn out to be satisifed with only the ρ pole on the high energy side much better and more locally than the corresponding conventional FESR. The ρ residues in the K-matrix are predicted to choose "nonsense" at $\alpha_\rho = 0$. If reduced ρ residues are defined as in the Regge limit of a πN-Veneziano formula, they are found to be practically constant between $t = m_\rho^2$ and $t \approx -0.4(\mathrm{GeV/c})^2$. The values agree well with those known at $t = m_\rho^2$ and with results from high-energy fits. (auth)

34667 K$^+$p BACKWARD DISPERSION RELATIONS. Nielsen, H.; Oades, G. C. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; B41: No. 2, 525-50(1972).

Various sets of K$^+$p phase shifts are studied for consistency with backward dispersion relations. The simplest interpretation of the backward invariant amplitudes is obtained for the Sens γ-solution with the phases smoothed below 700 MeV/c. Using SU(3) to relate the couplings $G_{\rho KK}$ and $G_{\omega KK}$ to $G_{\rho\pi\pi}$ and taking values for the ρ- and ϵ-couplings from fits to πN backward dispersion relations, two relations between vector $G_{\omega KK}$, tensor $G_{\omega NN}$ and $G_{\epsilon KK}/G_{\epsilon\pi\pi}$ are obtained. Assuming tensor $G_{\omega NN} \approx 0$ it is found that $-1.9 \leq G_{\epsilon KK}/G_{\epsilon\pi\pi} \leq -0.9$ and $-14.7 \leq$ vector $G_{\omega NN} \leq -5.0$. (auth)

34668 PION–DEUTERON SCATTERING LENGTH. Kolybasov, V. M.; Kudryavtsev, A. E. (Inst. for Theoretical and Experimental Physics, Moscow). Nucl. Phys.; B41: No. 2, 510-24(1972).

The formula is obtained for πd scattering length by summing the infinite series of the nonrelativistic Feynman graphs. It generalizes Brueckner's result. Next it is shown that this result is greatly affected by the account of the terms corresponding to the nucleon kinetic energy in intermediate state. The p wave πN scattering effects are evaluated in single and double scattering graphs. The πd scattering length is calculated using these general formulas. The πN scattering lengths from a previous survey and Hulthen deuteron wave function are used. The result is $a_{\pi d} = -0.047$ fm. (auth)

34669 DETERMINATION OF THE PION–NUCLEON COUPLING CONSTANT FROM PION PHOTOPRODUCTION. von Holtey, G.; Schwela, D. (Univ., Bonn). Nucl. Phys.; B41: No. 2, 438-44(1972).

Three different methods for the determination of the pion nucleon coupling constant f^2 from single pion photoproduction data in the first resonance region are discussed. They all yield results for f^2 compatible with each other and with the results from investigations of πN and NN scattering. The determination from π^+ data alone (independent of πN phase shifts) yield the value $f^2 = (79.2 \pm 3.9) \times 10^{-3}$, while the determination using the Bonn multipole analysis (dependent on πN phase shifts) yields $f^2 = (76.9 \pm 4.5) \times 10^{-3}$. (auth)

34670 INTERPRETATION OF THE HIGH-ENERGY πN SCATTERING AMPLITUDES AND DATA. Hartley, B. J. (Imperial Coll. of Science and Tech., London); Kane, G. L. Phys. Lett.; 39B: No. 4, 531-8(15 May 1972).

The πN scattering amplitudes at 6 GeV/c are examined and physical interpretations are suggested. For isovector exchange they are shown to be correctly given by a conventional enhanced absorption model which takes into account the phase of the elastic scattering at the same energy, while for isoscalar exchange they are consistent with simple ideas in impact parameter space. The absolute phase of the isoscalar exchange is determined by internal consistency of the model, and a t dependence for the Pomeron is predicted. A number of general points are briefly discussed, including the mechanism causing the double zeros in the elastic polarizations, the importance of different effective trajectories for flip and nonflip amplitudes, the possibility that shrinkage will change with energy, the expectation that crossover zeros will move out with increasing energy, the origin of the isoscalar flip amplitude, and the peripherality of the amplitudes. (auth)

34671 ANALYSIS OF MESON–BARYON SCATTERING DATA IN THE (8,8) MODEL OF CHIRAL SYMMETRY BREAKING AND A POSSIBLE CONNECTION TO ELECTROPRODUCTION. Genz, H. (Univ., Karlsruhe, Ger.); Katz, J.; Steiner, H. Phys. Lett.; 39B: No. 4, 541-5(15 May 1972).

The σ-terms in elastic meson–baryon scattering are analyzed in any (8, 8) model of chiral symmetry breaking. Good agreement of the (πN) σ-term of Höhler, Jakob and Strauss ($\Sigma_{(\pi N)} = 47$ MeV) and the $(KN)_{I=1}$ σ-term of von Hippel and Kim ($\Sigma^1_{(KN)} = (180 \pm 55)$ MeV) with the remaining ones is obtained. Alternatively use is made of a Schwinger term sum rule derived by Jackiw, van Royen and West and correlate meson–baryon scattering data to electroproduction in the (8, 8) model of Barnes and Isham. Electroproduction data then allow us to predict $\Sigma^1_{(KN)} = 232$ MeV to be predicted from $\Sigma_{(\pi N)} = 47$ MeV. This is in excellent agreement with the $(KN)_1$-value of von Hippel and Kim. (auth)

Strong (Baryon No. $\geq$ 2)

Refer also to abstract 35017.

34672 (INR–1352) K$^-$ CAPTURE IN $^{6\ 7}$Li AND THE FORMATION OF EXCITED HYPERNUCLEI /^{4}He*, ^{4}H*/. Deloff, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1971. 11p. (CONF-710911–14). Dep. NTIS (U. S. Sales Only).

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

The production rates of the excited hypernuclei ^{4}He* and ^{4}H* resulting from K$^-$ capture in ^{6}Li and ^{7}Li were calculated assuming the impulse approximation and the cluster model. Also the momentum distributions of these hypernuclei and the accompanying pion are obtained. (auth)

34673 (ITF–71–115–E) LOW-ENERGY SUM RULES FOR NEUTRON–PROTON SCATTERING. Lend'el, V. I.; Tovtin, E. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 17p. Dep. NTIS (U. S. Sales Only).

Low-energy dispersion sum rules for s- and d-partial waves of np scattering with correct threshold behavior are obtained. The energy dependence of the partial amplitudes is also calculated. It is shown that the introduction of only one pole according to the effective-range allows one to obtain a good agreement of the calculated amplitude with the data of phase-shift analysis. (auth)

34674 (NP–19314) QUARK CONTENT OF A PHENOMENOLOGICAL p-p POTENTIAL. Lilja, I. A. (Jyvaskyla Univ. (Finland). Dept. of Physics). Oct 1971. 13p. Dep. NTIS (U. S. Sales Only).

The relation $N_0 = 32.8 - 7.2 \log_{10} m_q$($m_q$ in MeV) is derived between the number of sub-nucleonic particles in the proton and free quark mass m_q. It follows from this constraint that in the "naive" quark model ($N_0 = 3$) m_q is about 14 GeV. (Finland)

34675 PROPERTIES OF HYPERNUCLEI IN REACTIONS UNDER THE INFLUENCE OF HIGH-ENERGY PROTONS AND ELECTRONS. Kozlov, M. I.; Lebedev, A. I.; Fetisov, V. N. Kratk. Soobshch. Fiz.; No. 11, 45-50(Nov 1971). (In Russian).

A new method is proposed for investigating hypernuclei and obtaining information on the masses, spectra of the excited states, and quantum numbers of the pertinent levels of the hypernuclei. In processes of the type $a - Z^A \rightarrow a' + K^+ - A^{(Z-1)A}$, the scattered particles a′ and K^+ mesons at coincidence are recorded. The cross sections were evaluated for the processes: $p - {}^{12}C \rightarrow p' + K^+ + {}_\Lambda B^{12}$ and $e - {}^7Li \rightarrow e' + K^+ + {}_\Lambda He^7$. (K.S.W.)

34676 COULOMB PRODUCTION. Faeldt, G.; Julius, D.; Pilkuhn, H.; Muellensiefen, A. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B41: No. 1, 125-40(1972).

Production of hadrons in the Coulomb field of the nucleus is studied. The Coulomb phase and the nuclear absorption of incident and produced hadrons are taken into account, leading to a form rather different from the conventionally used nuclear electric form factor. A simple analytic expression for the integrated production cross section is given, and applied to the calculation of the Σ^0 lifetime. Hadronic background problems and the possibility of interference measurements are discussed and detailed calculations performed for $K \rightarrow K^*$ conversion. Finally we treat corrections due to electron screening which become important at cosmic ray energies. (auth)

34677 ANTIPROTON ANNIHILATION ON DEUTERON AND BOUND STATES IN THE NUCLEON–ANTINUCLEON SYSTEM. Bogdanova, L. N.; Dal'karov, O. D.; Shapiro, I. S. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Rev. Lett.; 28: No. 21, 1418-21(22 May 1972).

The momentum distributions of the recoil nucleon (spectator) in the reaction $\bar{p} + d \rightarrow n + (N\bar{N})$ were calculated by taking into account the possible levels in the $N\bar{N}$ system. The comparison of the theory with the experimental data on p annihilation at rest shows the existence of a $\bar{p}n$ bound D state with quantum numbers $J^{PG} = 1^{\pm}$. (auth)

34678 PREDICTION OF BINDING ENERGIES OF LIGHT HYPERNUCLEI. Bhaduri, R. K.; Nogami, Y. (McMaster Univ., Hamilton, Ont.). Phys. Rev. Lett.; 28: No. 21, 1397-1400(22 May 1972).

It is pointed out that Garvey and Kelson's mass formulas, which relate masses of adjoining nuclides, hold remarkably well for Λ separation energies of light hypernuclei. The binding energies of a number of hypernuclei in the p shell are predicted, including the controversial cases of ${}^6_\Lambda Li$ and ${}^9_\Lambda B$. (auth)

34679 INCLUSIVE EXPERIMENTS AND TRIPLE-POMERON VERTEX. Miyake, S.; Takahashi, A. (Tohoku Univ., Sendai). Lett. Nuovo Cim.; 3: No. 18, 739-42(29 Apr 1972).

Assuming the finite-energy sum rule for the pomeron-proton scattering, the dimensionless parameter η_p associated with the triple-pomeron vertex is estimated for the inclusive process $p + p \rightarrow p + X$. (L.B.S.)

34680 ANALYSIS OF DECAYS OF ${}^7_\Lambda Li$. Chlebowska, D. (Inst. for Nuclear Research, Warsaw). Acta Phys. Pol.; B3: No. 2, 325-32(Mar-Apr 1972).

The distributions of the p-α and d-α relative energy of the ${}^7_\Lambda Li \rightarrow p + d + \alpha + \pi^-$ decay products are calculated with the use of the $\Phi(d-\alpha-\Lambda)$ cluster wave function of ${}^7_\Lambda Li$. For ${}^7_\Lambda Li \rightarrow {}^4He + {}^3He + \pi^-$ decay the distributions of the ${}^3He-{}^4He$ relative energy and angular distribution of the ${}^3He$ are calculated with the use of the $\Phi(d-\alpha-\Lambda)$ and $\Phi({}^3He-t-\Lambda)$ cluster wave functions for the description of the ${}^7_\Lambda Li$. It is shown that the mentioned angular distribution strongly depends on the structure of the ${}^7_\Lambda Li$. The energy distributions for both models of the ${}^7_\Lambda Li$ decay agree with the experimental data. (auth)

34681 SEMICLASSICAL MODEL OF HIGH-ENERGY SCATTERING. Bechler, A.; Bialynicki-Birula, I. (Univ., Warsaw). Acta Phys. Pol., B3: No. 2, 163-78(Mar-Apr 1972).

The problem of high energy p–p scattering is investigated in the approximation in which the colliding particles are treated classically. It is assumed that the interactions of these particles can be described in terms of some (unspecified in detail) short range interactions and in terms of massive vector mesons exchanges. It is shown that for a reasonable choice of the classical world lines of the protons the high energy elastic differential cross section is consistent with the Regge model predictions and with the experimental data. The amplitude of the inelastic π–p process with n vector mesons in the final state is also calculated. It is shown that, in general, the number of the produced vector particles is not governed by the Poisson distribution. (auth)

34682 MECHANISM OF INCLUSIVE REACTIONS AND INELASTIC SCREENING IN THE DEUTERON. Kaidalov, A. B.; Kondratyuk, L. A. JETP Lett. (USSR) (Engl. Transl.); 15: No. 3, 117-20(5 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 3, 170-3(5 Feb 1972).

The contribution of different elastic mechanisms to the shadow correction $\Delta = \sigma_p + \sigma_n - \sigma_d$ in the scattering of a hadron above 10 GeV, by a neutron is estimated. The interactions p + d, π + d, and K + d are considered. (J.F.P.)

34683 POSSIBILITY OF APPLYING THE PROCESS $pp \rightarrow ppe^+e^-$ FOR CALIBRATION OF CROSS-SECTIONS IN COLLIDING pp BEAMS. Budnev, V. M.; Ginzburg, I. F.; Meledin, G. V.; Serbo, V. G. (Inst. for Mathematics, Novosibirsk, USSR). Phys. Lett.; 39B: No. 4, 526-30(15 May 1972).

It is shown that the main contribution to the cross section of the $pp \rightarrow ppe^+e^-$ process is due to QED only. The differential cross section is written as a double integral. At $s \simeq 40$ GeV $\sigma > 0.1$ mb; the characteristic energies and emission angles of e^+, e^- are ~5 MeV and ~3°. (auth)

Particle Invariance Principles and Symmetries

General

34684 (ITF-72-6-E) WIGNER–ECKART THEOREM FOR NONUNITARY REPRESENTATIONS OF SEMISIMPLE LIE GROUPS. Klimyk, A. U. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 29p. Dep. NTIS (U. S. Sales Only).

An analog of the Wigner–Eckart theorem for the matrix elements of tensor operators transforming according to a finite-dimensional representation of a semi-simple group when the Hilbert space is decomposed into a direct sum of the spaces of irreducible (in the operator or topological sense) representations of the group under consideration is proved. The problem of equivalence and irreducibility of the tensor operators is considered. The question is discussed concerning the application of the theorem proved for the construction of the invariant wave equations and representations of Lie algebra and groups. (auth)

34685 SELF-ADJOINTNESS OF SOME REPRESENTATIONS OF FIELD ALGEBRA. Borisov, N. V.; Vasil'ev, A. N. (Leningrad State Univ.). Teor. Mat. Fiz.; 11: No. 1, 9-18(Apr 1972). (In Russian).

The essential self-adjointness is proved for the field algebra representations corresponding to the generalized free field and the field $:\varphi^2:(x)$, where $\varphi(x)$ is a free field. (auth)

34686 MATRIX ELEMENTS OF IRREDUCIBLE REPRESENTATIONS ON THE DE SITTER GROUP. Lizin, I. M.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Teor. Mat. Fiz.; 11: No. 1, 69-77(Apr 1972). (In Russian).

The system of recurrent differential equations is obtained for matrix elements of any irreducible representations of the pseudo-orthogonal rotation group O(4,1). The representations of the infinite as well as finite dimensionality are considered from the united point of view. The matrix elements of a special form are calculated, by means of which arbitrary elements can be calculated also. (auth)

34687 CLEBSCH–GORDAN COEFFICIENTS OF THE GROUP SL(2,C). Gavrilik, A. M. (Inst. of Theoretical Physics, Moscow). Teor. Mat. Fiz.; 11: No. 1, 56-68(Apr 1972). (In Russian).

The exact expressions are obtained for the Clebsch–Gordan coefficients of the tensor product of SL(2, C) irreducible unitary representations belonging to the principal and supplementary series. (auth)

34688 TOPOLOGICAL PROPERTIES OF A COMMUTANT OF FIELD ALGEBRA REPRESENTATION. Borisov, N. V. (Leningrad State Univ.). Teor. Mat. Fiz.; 11: No. 1, 19-22 (Apr 1972). (In Russian).

It is proved that the strict commutant of a closed representation of topological *-algebra is a W*-algebra. (auth)

34689 ALGEBRA OF THE NONCOMPACT GROUP O(3,2) AND THE HYDROGEN-ATOM RADIAL FUNCTIONS. Herrick, David; Sinanoglu, Oktay (Yale Univ., New Haven). Phys. Rev., A; 5: No. 6, 2309-13(Jun 1972).

The bound-state hydrogen-atom radial functions are used to construct a basis for a unitary representation of the algebra O(3,2). With the use of the O(3) subalgebra of this "radial algebra" matrix elements of r^s between states of different energy are shown to be completely expressible in terms of the matrix elements of r^{-2}. Matrix elements corresponding to the radial matrix elements of the dipole operator are shown to be proportional to the overlap of the radial functions. The continuum radial functions of constant energy are shown to provide a basis for a unitary representation of O(2,1). (auth)

34690 TRANSFORMATION PROPERTIES UNDER BROKEN SYMMETRY. Bace, M. (Univ. of Rochester, N. Y.). Nucl. Phys.; B41: No. 2, 493-509(1972).

A general condition is derived which allows a local field (in an arbitrary field theory) to belong simultaneously to a fixed representation of the Lorentz group and a given representation of a broken symmetry group. Specializing to local currents one obtains the condition of Gross and Jackiw for a complete current algebra, the condition of Beg et al. for the dimension of a current component to be independent of its Lorentz index, and the condition necessary for covariant derivatives in broken chiral theories to be covariant. Also, one is able to understand observations of Kimel on the failure of complete current algebra in gauge field models with mass-breaking terms, those by Takahashi and others on the impossibility of assigning a dimension to Duffin–Kemmer scalar and Klein–Gordon vector fields, and some other specific results. The above condition allows a critical examination of operator product expansions. The point of the paper is in its generality; it makes possible a unified view of a large number of specific results and observations. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 34631 and 35039.

34691 LEPTONIC AND HADRONIC SYMMETRIES. Freund, P. G. O. (Univ. of Chicago). Nucl. Phys.; B41: No. 1, 35-44 (1972).

Two models for a gauge theory of the weak and electromagnetic interactions of leptons and hadrons are considered. The first model is based on the group $[SU(3)]^4 = SU(3) \times SU(3) \times SU(3) \times SU(3)$, the fundamental representation of which is spanned by left and right-handed lepton and quark triplets. The lepton triplet involves the ν_e and $\bar{\nu}_\mu$ combined to a 4 component field, the e^- and the μ^+. A spontaneous symmetry breakdown is caused by the appearance of tadpoles. It is proved that the tadpoles responsible for the lepton and quark masses, by themselves, do not break the symmetry in a manner compatible with the observed universality properties of weak interactions. Many additional scalar fields are needed and they are classified into specific $[SU(3)]^4$ multiplets. The model can account for the suppression of $|\Delta S| = 1$ neutral current induced semileptonic decays ($K \rightarrow \pi\nu\bar{\nu}$, $K^0 \rightarrow \mu^+\mu^-$, etc...) A quartet model based on the symmetry $U(4) \times U(4)$ is discussed. The model is simpler, but has to confront the absence of "charmed" hadrons in the low ($m \leq$ 2-3 GeV) mass region. (auth)

Applications (Strong)

Refer also to abstract 34671.

34692 NEW SYMMETRIES FOR 38 INTERACTIONS. Bell, A. B. (Lehigh Univ., Bethlehem, Pa.); Bell, D. M. Particles Nucl.; 3: No. 4, 222-9(Apr 1972).

Thirty-eight particle interactions and decays are tested by means of a new symmetric structure, based on a symmetric wheel which includes groups as a special case. The effect for particle physics is that symmetry may occur without the existence of a group. In two forbidden cases, the symmetry is of lower order; while in thirty-five permitted cases, the symmetry is of higher order. (L.B.S.)

34693 CHIRAL SYMMETRY REALIZATION IN THE QUARK MODEL. Pagels, Heinz (Rockefeller Univ., New York). Phys. Rev. Lett.; 28: No. 22, 1482-5(29 May 1972).

Chiral symmetry realizations of the quark-gluon model are considered in the absence of self-energy insertions for the gluon and photon, so the bare fermion mass vanishes. The conditions which realize the chiral symmetry with Nambu–Goldstone bosons as bound states are exhibited. A formal argument indicates that in this model electromagnetic corrections to the strong interactions are then finite to leading order and possibly all orders. (auth)

34694 MASS FORMULAS IN THE SCALE U(6.6)-SYMMETRY. Nikolov, A. V. God. Sofii. Univ., Fiz. Fak.; 62: 13-19(1967-1968). (In Bulgarian).

The earlier proposal by the same author (Preprint Joint Institute for Nuclear Research Pr-3407, Dubna, 1967) is used for mass operator for mesons with spin and parity 0^-, 1^-, 2^- and 0^+, which are contained in the first several members of an infinite scale representation (1.1) + (6.6*) + (21.21*) + (56.56*) . . . . of the 6.6 group. Mass formulas for this representation were first obtained by D. Ts. Stoyanov and I. T. Todorov (Ann. Phys., 41, 349 (1967)). The physical states corresponding to particles are determined, as proper vectors of the mass operator and the operators of the squares of the spin and the isotopic spin, and also of the charge, hypercharge, baryon charge and the parity, all being constructed by means of the generators of the representation. The mass relations obtained in the work for the known particles are satisfied with very good precision. New particles are predicted and their masses and remaining quantum numbers determined. (Abstr. Bulg. Sci. Lit., Math., Phys. Astron., Geophys., Geod.)

Field Theories

General

34695 TEORIYA POLYA. (Field Theory). Ovchinnikov, I. K. Moscow; Izdatel'stvo Nedra (1971). 312p.

The theory of gravitational and electrical fields in a homogeneous medium is treated, then follows treatments of electric and magnetic fields of direct currents, the electromagnetic field of alternating currents, and the basic theory of elasticity. Free use is made of vector and tensor methods, and supplementary information is provided in this connection as required. Theoretical aspects are accompanied by practical examples which illustrate the application of the general theory to the solution of concrete problems. Some of the latter are directly related to geophysical exploration. Some problems deal with an alternating electromagnetic field, and are of interest to workers in the field of electro-prospecting with alternating current. (13 references) (tr-auth)

34696 FIELD THEORY. II. MINIMUM KINETIC MOMENT DURING MOTION IN A NATURAL CENTRAL FIELD. Gulak, Yu. K. Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 52-6(1971). (In Russian).

The substitution of undefined initial conditions by a boundary requirement for a natural central field $F = -\alpha/r^2$ shows that a minimum distance r_0 exists, so that a particle cannot spontaneously approach closer to the center of the field than r_0. This requirement is spread to all particles by inserting the concept of the field-dynamic field. An equipotential surface of the nucleus is a rational, natural, system of energy reference. A connection was established between r_0 in a gravitational field and the mass of a central body which determines the minimum moment of momentum of the particle. (tr-auth)

34697 NONCOMMUTATIVE REPRESENTATION OF CLASSICAL DYNAMICS. CONNECTIONS WITH FIELD QUANTIZATION. Crawford, J. A. Nuovo Cim.; 9B: No. 1, 1-40(11 May 1972).

Einstein's program of classical field theory for physics has not been proven unrealizable. However, Bell has shown that a theory of this type could not be consistent with all of the predictions of quantum mechanics. It is reasonable to assume that fields in a theory of the Einstein type could be described as classical dynamical systems. The conditions for an operator representation in Hilbert space of the phase functions of a finite classical system are formulated. It is proved that such a representation cannot be commutative. The Weyl representation fulfills the required conditions: in Appendix A it is shown to map the quadratically integrable phase functions isometrically into the Hilbert–Schmidt operators. It follows that the image U of the phase probability density is a statistical operator in the sense of von Neumann, though not generally nonnegative definite. The Weyl representation is then formally extended to infinite classical systems and applied to interacting relativistic tensor wave fields (spinor fields, not being single valued, present difficulties) With the choice $\hbar = \pi^{-1}$, this representation satisfies the requirements of canonical quantization. The Hamiltonian operator and operators for the usual field quantities are the same as in quantum field theory. However, an additional field interaction term appears, modifying von Neumann's equation for the time dependence of U. Essential divergence difficulties should not arise, since no divergences occur in classical field theory. This representation of classical field theory is amenable, in just the same way as quantum field theory, to a configuration space representation and a corresponding particle interpretation. These aspects will be discussed in a later publication. (auth)

34698 UNIFORM ELECTROMAGNETIC–GRAVITATIONAL FIELD. Rao, K. N. Srinivasa; Gopala Rao, A. V. (Univ. of Mysore, India). Phys. Lett.; 39A: No. 4, 291-2(22 May 1972).

A solution of the coupled Einstein–Maxwell equations, describing an electromagnetic field with an associated uniform gravitational field, is discussed. (auth)

Quantum Field Theory

Refer also to abstracts 34685 and 34690.

34699 (ITF–71-108-E). ASYMPTOTIC FIELDS WITHOUT ULTRAVIOLET CUTOFFS IN MODEL FIELD THEORIES IN TWO SPACE–TIME DIMENSIONS. Yakymiv, Ya. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 12p. Dep. NTIS (U. S. Sales Only).

It is proved that boson asymptotic fields for the Yukawa model in two space-time dimensions with spatial and ultraviolet cutoffs and the model $(p(\mathscr{L}_2)(g) + Y(g,x)_2)$, where p(y) is the polynomial of even degree not more than four, are essentially self-adjoint. The asymptotic fields for the models under consideration exist as weak graph-limits when $\mathcal{H} \rightarrow \infty$. (auth)

34700 MULTICHANNEL INTERACTION OF PARTICLES WITH IDENTICAL QUANTUM NUMBERS AND COMPOSITENESS CONDITIONS. Braun, M. A.; Izergin, A. G.; Eides, M. I. (Leningrad State Univ.). Teor. Mat. Fiz.; 11: No. 1, 44-55 (Apr 1972). (In Russian).

The quantum field theory of particles with identical quantum numbers interacting with several channels is considered. The formation of composite particles in the theory is investigated. Compositeness conditions are deduced which make some of the particles composite. These conditions generalize the well known one-particle conditions $Z_1 = 0$ and $Z = 0$. The conditions are symmetrical with respect to all the particles. The formalism is further generalized to include the case of self-interacting particles. (auth)

34701 UNIQUENESS OF THE HAMILTONIAN AND OF THE REPRESENTATION OF THE CCR FOR THE QUARTIC BOSON INTERACTION IN THREE DIMENSIONS. Eckmann, Jean-Pierre (Brandeis Univ., Waltham, Mass.). ; Osterwalder, Konrad. Helv. Phys. Acta; 44: No. 7, 884-909(31 Dec 1971).

Glimm has constructed a Hamiltonian for the $(:\phi^4:)_{2+1}$ interaction with space cutoff, using a truncated version of the formal wave operator in order to define a domain for this Hamiltonian. For a wide class of such truncations one obtains unitarily equivalent representations of the canonical commutation relations in the sense of Fabrey. Unitary equivalence of the closures of the Hamiltonians obtained for many different truncations is established. (auth)

34702 ALGEBRAIC METHODS IN STATISTICAL MECHANICS AND QUANTUM FIELD THEORY. Emch, Gerard G. Interscience Monographs and Texts in Physics and Astronomy. Volume XXVI. New York; John Wiley and Sons, Inc. (1972). 346p. $19.95.

The discussion covers Fock space, the emergence of the algebraic approach, global theories, canonical commutation and anticommutation relations, and quasi-local theories. (J.F.P.)

34703 FIELD THEORIES IN THE INFINITE-MOMENTUM FRAME. Soper, Davison Eugene. Stanford, Calif.; Stanford Univ. (1971). 135p. University Microfilms Order No. 72-11,668.

Thesis.

The formal foundations of quantum electrodynamics and several other field theories are examined in the infinite-momentum frame. The infinite-momentum frame is interpreted as being given by a change of space-time variables, thus avoiding limiting procedures. The two coordinates describing position transverse to the z-axis are left unchanged. The other two coordinate axes, one of which plays the role of the "time"-axis, are chosen along the light cone in the t-z plane. A "time"-ordered perturbation series is derived for quantum electrodynamics and how such a series arises from a canonical formulation of the field theory is shown. The methods employed do not involve any high energy approximations. However, it is believed that the "exact" field theories in the infinite-momentum frame may be well adapted for high energy approximations. (TSS) (Diss. Abstr. Int., B)

34704 QUANTUM ELECTRODYNAMICS AT INFINITE MOMENTUM: APPLICATIONS TO HIGH ENERGY SCATTERING. Kogut, John Benjamin. Stanford, Calif.; Stanford Univ. (1971). 137p. University Microfilms Order No. 72-11,590.

Thesis.

The infinite-momentum frame has found application in several branches of high energy physics. Perhaps its most famous contribution has appeared in current algebra where Fubini and others used it as a tool to construct sum rules. However, it has become apparent in the intervening years that the limit itself is of considerable importance and worth more attention. Weinberg, and later Susskind, and Bardakci and Halpern, have discussed perturbation theory, relativistic kinematics, and equations of motion from this new point of view. All of these workers have been impressed with the fact that dynamics at infinite-momentum possesses a rigorous and productive nonrelativistic interpretation. These questions are explored within the framework of quantum electrodynamics. The major goal is to develop an approximate ultrarelativistic theory of QED which provides a simple description of extremely high-energy phenomena. (TSS) (Diss. Abstr, Int., B)

34705 PERTURBATION THEORY OF TWO PARTICLE BOUND STATES IN QED FOR PARTICLES OF SPIN ≤ 1. Lund, Carl Meredith. Urbana, Ill.; Univ. of Illinois (1971). 78p. University Microfilms Order No. 72-12,276.

Thesis.

A generalization of Salpeter's approach to solving the Bethe–Salpeter equation for the hydrogen atom to the case of any two particles of spin ≤ 1 is presented. In order to preserve the same general form of Salpeter's scheme the Kemmer–Duffin equations are used to describe the spin-1 or spin-0 particles. The general method involves separating out the single scalar photon exchange as the zero-order problem, whose approximate solution is the ordinary Schroedinger equation solution, and developing a perturbation theory to calculate the effects of the other irreducible diagrams of the Bethe–Salpeter equation. As an example of how to work with the formalism developed here, the order $\alpha m/M$ corrections to the hyperfine structure of atomic deuterium are worked out under the assumption of the minimal electromagnetic interaction. (Diss. Abstr. Int., B)

34706 BOUND STATE POLES OF THE FORM FACTORS IN EIKONAL APPROXIMATION AND INFINITE COMPONENT WAVE EQUATIONS. Barut, A. O.; Aydin, Z. Z. (Univ. of Colorado, Boulder). Nucl. Phys.; B41: No. 1, 150-6(1972).

The form factor in eikonal approximation is investigated for the whole region of momentum transfer t in electrodynamics and in ϕ^3 theory, and the poles in the time-like region below the threshold are determined. A covariant mass formula is obtained similar to the one derived from four point functions in eikonal approximation. The mass formula does not become imaginary for large values of the coupling constant. The relation to positronium Regge trajectory and infinite component wave equations is discussed. (auth)

34707 VARIANT OF THE STUECKELBERG FORMALISM FOR MASSIVE GAUGE FIELDS AND APPLICATIONS. Ghose, P.; Das, A. (Visva-Bharati Univ., Santiniketan, India). Nucl. Phys.; B41: No. 1, 299-316(1972).

A variant of the Stückelberg formalism for massive neutral and non-Abelian gauge fields is studied in detail. Applications to hadron electrodynamics are discussed. The major new result is that if the isovector, hadronic, electromagnetic current is proportional to the neutral ρ meson field operator, the finite c-number Schwinger term in the current commutators can be eliminated altogether by introducing an unphysical, negative metric, scalar particle without violating unitarity. (auth)

34708 CALCULATIONS IN CONFORMAL INVARIANT FIELD THEORIES. Symanzik, K. (Deutsches Elektronen-Synchrotron, Hamburg). Lett. Nuovo Cim.; 3: No. 18, 734-8(29 Apr 1972).

An analysis is made of Migdal's algebraic vertex bootstrap conditions and other equivalent algebraic bootstrap equations. It is shown how to obtain the general term in these bootstrap relations by way of a simple manifestly conformal invariant calculus. (L.B.S.)

34709 NONPARALLEL CONVECTION OF LIGHT. Kantor, W. Lett. Nuovo Cim.; 3: No. 18, 747-8(29 Apr 1972).

The possibility of a generalized Fizeau experiment which would test the relativistic velocity addition theorem for motion of the medium in a direction not parallel to the direction of light propagation was suggested by Neuberg and Phipps (Am. Journ. Phys. 39: 1079 (1971)). It is pointed out that this suggestion is of much greater importance than it might first appear and that the experiments should be undertaken with some serious urgency. (L.B.S.)

34710 VALIDITY OF THE INFINITE-MOMENTUM FRAME CANONICAL FORMALISM FOR SIMPLE LOOP DIAGRAMS. Bouchiat, C.; Fayet, P.; Sourlas, N. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Lett. Nuovo Cim.; 4: No. 1, 9-15(6 May 1972).

It is shown that the Bjorken–Kogut–Soper infinite momentum formalism applied to a properly regularized field theory, leads to the same result as the covariant formalism even when loops are present. The formalism is applied to loop diagrams, and more precisely, the nucleon and meson self-energy, and the meson–nucleon vertex. (L.B.S.)

34711 RADIATIVE PROBLEMS AND QUANTUM ELECTRODYNAMICS. Brodsky, Stanley, J. (Stanford Univ., Calif.). pp 13-35 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Recent advances in quantum electrodynamics are reviewed, which include the anomalous magnetic moment of the electron and Lamb shift tests. The remainder of this review is concerned with the two photon process for particle production by colliding beams. (L.B.S.)

34712 QUANTUM ELECTRODYNAMICS AT HIGH ENERGIES. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge, Mass.); Wu, Tai Tsun. pp 147-61 of Proceedings of the 1971 International Symposium on Electron and Photon Interactions at High Energies. /Mistry, N. B. (ed.). Ithaca, N. Y.; Cornell Univ. (1972).

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Some of the most interesting developments over the past four years in quantum electrodynamics at high energies are reported. The results given are of two distinct kinds: those which are applicable to electrons and photons only; and those which are applicable to hadrons as well. The first kind includes most of the computational results on asymptotic Feynman amplitudes. The topics are as follows: lowest-order calculation; impact-factor representation; highest-order diagrams; and limiting behavior of cross section. It is shown that, in quantum electrodynamics with massive photons, the Froissart bound is almost saturated. A summary of the arguments leading to this conclusion is: (i) one-tower diagrams give a cross section increasing as a power of s; (ii) this implies that the interaction extends into logarithmically large transverse distances; (iii) the cross section therefore rises logarithmically. (L.B.S.)

34713 DETERMINATION OF THE HYDROGENIC-CARBON LAMB SHIFT VIA $2S_{1/2}$ METASTABLE QUENCHING. Murnick, D. E. (Bell Telephone Labs., Murray Hill, N. J.); Leventhal, M.; Kugel, H. W. Phys. Rev. Lett; 27: No. 24, 1625-8(13 Dec 1971).

The Lamb shift was measured in the n = 2 state of hydrogenic carbon-12. The result is 780.1 ± 8.0 GHz as compared with the quantum-electrodynamic calculation of 783.7 ± 0.24 GHz. The ratio of the electron-pickup cross section to the $2S_{1/2}$ metastable state to the total electron-pickup cross section was also determined as 0.022 ± 0.010 in argon at 25 MeV. (auth)

34714 $(\phi^{2n})_2$ QUANTUM FIELD THEORY: LORENTZ COVARIANCE. Rosen, Lon M. (Univ. of California, Berkeley). J. Math. Anal. Appl.; 38: No. 2, 276-311(May 1972).

It is shown that the $(\phi^{2n})_2$ quantum field theory model is Lorentz covariant in the sense that the Poincaré transformation $\phi(x,t) \rightarrow \phi(\{a,\Lambda\}(x,t))$ is locally unitarily implementable in Fock space. It follows that the corresponding theory of local observables satisfies all of the Haag–Kastler axioms. The method of proof generalizes that of Cannon and Jaffe for the $(\phi^4)_2$ model and relies on higher order estimates for the generator of Lorentz rotations. (auth)

34715 RELATIVISTIC MOTION IN TWO SPACE-LIKE DIMENSIONS. Taylor, N. W. (Univ. of New England, Armidale, Australia); Marsh, L. McL. J. Proc. Roy. Soc. N. S. W.; 103: 119-22(1970).

In relativity theory a set of coordinate transformations suitable for investigating conditions experienced directly by an accelerated observer can be found. These transformations simplify the discussion of topics such as uniform rotation and the Thomas precession. (auth)

34716 NATURE OF TIME AND ITS MEASUREMENT. Prokhovnik, S. J. (Univ. of New South Wales, Sydney). J. Proc. Roy. Soc. N. S. W.; 103: 123-6(1970).

Einstein's new approach to space and time stimulated a complete re-evaluation of these concepts. In particular, his notion of time-dilatation, with its promise of journeys into the future (and also into the past?), stirred the imagination of philosophers and writers of fiction. In the wake of Minkowski, time became merely a fourth dimension and scientists are still arguing about the "arrow of time" and the possibility of its reversal. It is suggested that neither special relativity (nor any other physical theory) provides support to most of these speculations. Indeed Einstein's approach affirms that time is not an absolute concept apart from nature, but that it is a property of nature and can only be measured in terms of natural processes. Some implications of this viewpoint are outlined, and mention is made of a cosmological interpretation of the special theory which provides a universal measure of time through the concept of "cosmic time." (auth)

34717 ANOMALOUS WARD-IDENTITIES, GAUGE-VARIANCE, AND APPEARANCE OF GHOSTS IN HIGGS–KIBBLE TYPE THEORIES. Korthals Altes, C. P.; Perrottet, M. (CNRS, Marseille). Phys. Lett.; 39B: No. 4, 546-8(15 May 1972).

It is shown how anomalies of the Adler type obliterate unitarity of otherwise renormalizable theories of the Higgs–Kibble type. (auth)

Gravitation and General Relativity

Refer also to abstract 34610.

34718 IDENTITY RELATIONS BETWEEN EQUATIONS OF THE NEWMAN–PENROSE FORMALISM IN THE SPINOR DESCRIPTION. Herrera, L. A. (Institut Henri Poincare, Paris). Compt. Rend., Ser. A; 274: No. 5, 427-30(31 Jan 1972). (In French).

Papapetrou has explained in two recent articles the tensorial nature of the Newman–Penrose formalism. In the first, it is demonstrated that the complete system of Newman–Penrose equations can be obtained from a basic equation when the appropriate integral conditions are considered. In the second, the identity relations existing between these equations are deduced. These identities have already been deduced in spinor form by direct calculation under the hypothesis of the validity of Einstein's equations in vacuo $R\mu\nu = 0$. A study is presented of these equations using the spinor calculation and suppressing the restricting hypothesis $R\mu\nu = 0$. (France)

34719 SPACE–TIME STRUCTURE ASSOCIATED WITH AN ASYMMETRIC MOMENTUM-ENERGY TENSOR. Clerc, R. L. (Univ., Toulouse). Compt. Rend., Ser. A; 274: No. 6, 525-8 (7 Feb 1972). (In French).

If space–time is interpreted as a V_4 variety pseudo-Riemanian with asymmetric connection, a purely geometric Lagrangian (generalizing the Einstein R) variational principle can be derived for the asymmetric Einstein equations, where $T_{\alpha\beta} = V_\alpha P_\beta$; in order to accomplish this, it is sufficient to consider V_4 as the diagonal subvariety of a particular variety V_8. (France)

34720 AXIALLY SYMMETRIC DISTRIBUTIONS OF MATTER IN GENERAL RELATIVITY. Voorhees, Burton Hamilton. Austin, Tex.; Univ. of Texas (1971). 108p. University Microfilms Order No. 72-11,430.

Thesis.

Relativistic kinetic theory and the theory of surface layers in general relativity theory are used to study the properties of disks composed of collisionless particles all having the same rest mass. As a preliminary step properties of the Weyl metrics in spheroidal coordinates are studied, including asymptotic behavior, intrinsic geometry of the surfaces of constant potential, multipole moments, and extensions. The Weyl metrics in oblate spheroidal coordinates lend themselves naturally to interpretation as the exterior fields of disks of matter. The general form of the surface stress energy momentum tensor is obtained and shown to correspond to a disk of counter-rotating matter. These are used to determine the distribution function which will give a solution of the self-consistent field problem. It is shown that kinematic restrictions do not prohibit the construction of such disks exhibiting arbitrarily large central red shifts. Finally the stability of these model disks is examined. A criteria is given for the stability of the individual particle orbits and the response of these orbits to external perturbations such as gravitational radiation is determined. The perturbed field equations are studied to obtain statements on overall stability. (Diss. Abstr. Int., B)

34721 NULL TETRAD FORMULATION OF THE EQUATIONS OF MOTION IN GENERAL RELATIVITY. Silaban, Pantur. Syracuse, N. Y.; Syracuse Univ. (1971). 73p. University Microfilms Order No. 72-11,864.

Thesis.

The existence of gravitational radiation damping in the linearized general relativity is investigated by studying the equations of motion for monopoles in the null tetrad formalism. The structure of the Einstein vacuum field equations and the Newman–Penrose equations is thoroughly studied. Also the approximation technique is developed in detail. It is shown that, up to the second order results, the radiation damping terms do not occur if one considers only the self-interactions. (Diss. Abstr. Int., B)

34722 ELECTRIC WEYL SPACETIMES AND THE STATIONARY PROBLEM. Voorhees, B. H. (PARS Coll., Tehran). Phys. Lett.; 39A: No. 2, 114(24 Apr 1972).

A simple transformation is used to show that every electrified Weyl spacetime defines a corresponding stationary and axially symmetric spacetime, and vice-versa. Also, if the stationary solution is to be asymptotically flat, then the generating Weyl spacetime cannot be asymptotically flat, but must behave asymptotically as a cylindrical spacetime. (auth)

34723 CONCEPTUAL FOUNDATIONS OF CONTEMPORARY RELATIVITY THEORY. Graves, John Cowperthwaite. Cambridge, Mass.; Massachusetts Institute of Technology Press (1971). 372p. $15.00.

The topics covered include scientific realism versus the empiricist error, the logical error, the role of models, conceptual geography and Plato, Descartes geometrization of physics, Newtonianism and atomism, field theories, foundation principles of general relativity, measurement in general relativity, and the law of motion and the field law. Also covered are approximations, dimensions, and empirical tests, the conceptual novelty of general relativity: interdependence, the new dynamics and the role of time, the incorporation of the electromagnetic field, the wormhole model, and matter versus space: an answer to Mach. (J.F.P.)

34724 ELECTRO-GRAVITATIONAL MATTER. Rankin, James Edwin. New York; Yeshiva Univ. (1971). 84p. University Microfilms Order No. 72-11,157.

Thesis.

An electromagnetic theory of matter suggested by the Lorentz electron theory is proposed. Maxwell's equations and asymptotic agreement with the Lorentz force law are retained. However, the electromagnetic sources are regarded as finite, continuous entities for which the total Lorentz force density vanishes everywhere. This condition replaces the integral condition of Lorentz and removes difficulties of that theory. As a result, the source structure can no longer be freely assigned, but is determined by the field equations. This is regarded as desirable. The proposed theory is then derived from a simple, action principle, and its satisfactory propagation of initial value data is verified. In doing these things, one discovers that a pseudoscalar field is also automatically present in the formalism. However, the new field carries no energy or momentum. Application of the virial theorem then reveals restrictions which prohibit static, localized, well-behaved, global solutions. To overcome this within a classical framework, general relativistic gravitation is included. The result overcomes the virial theorem's restrictions on the purely electromagnetic theory. The prospects for elementary particles as solutions to the equations are then discussed. (Diss. Abstr. Int., B)

34725 STATIONARY CHARGED-DUST DISTRIBUTION IN GENERAL RELATIVITY. Misra, R. M.; Pandey, D. B.; Srivastava, D. C. (Univ. of Gorakhpur, India). Nuovo Cim.; 9B: No. 1, 64-8(11 May 1972).

The Einstein–Maxwell equations for a stationary gravitational field are investigated. The space is assumed to be filled with charged incoherent matter. It is then shown that, if one assumes a vanishing Lorentz force everywhere, the charge density is always an arbitrary constant multiple of the mass density. (auth)

34726 LLOYD MIRROR INTERFEROMETER EXPERIMENTS ON THE SPEED OF LIGHT FROM A MOVING SOURCE. Kantor, W. Nuovo Cim.; 9B: No. 1, 69-76(11 May 1972).

The Lloyd mirror interferometric experiments, by Tolman in 1910 and by Beckmann and Mandics in 1964, on the speed of light from a moving source are shown to be unproductive of conclusive results. The related Rotz experiment in 1963 with moving slits is inconclusive since no experimental knowledge of the effect of slits on the speed of light is known. The inherently avoidable null results of certain other related closed-path interferometric experiments, on the speed of light from a moving source, are also inconclusive for reasons closely similar to those involved in the inherently unavoidable null results in the Lloyd mirror work. (auth)

34727 GRAVITATIONAL INSTABILITY OF TWO STREAMS IN THE PRESENCE OF A UNIFORM ROTATION AND A UNIFORM MAGNETIC FIELD. Sengar, R. S.; Khare, H. C. (Univ. of Allahabad, India). Nuovo Cim.; 9B: No. 1, 122-30(11 May 1972).

The gravitational instability of an interface separating two semi-infinite homogeneous streams, in the presence of a uniform rotation Ω and a uniform magnetic field H respectively perpendicular and parallel to the direction of the streaming motion, is investigated. The streams of uniform densities ρ_1 and ρ_2 move along the interface with uniform velocities U_1 and U_2. Two cases of waves propagating parallel and perpendicular to the direction of streaming are discussed, and the dispersion relations and the critical wave numbers are obtained in various cases of physical interest, including the case of a single homogeneous medium. For perpendicular propagation the results are independent of the streaming motion. (auth)

34728 STATIC GRAVITATIONAL MULTIPOLES: THE CONNECTION BETWEEN FIELD AND SOURCE IN GENERAL RELATIVITY. Clarke, C. J. S. (Cambridge Univ., Eng.); Sciama, D. W. Gen. Relativity Gravitation; 2: No. 4, 331-45(1971).

Multipole moments have already been defined in general relativity independently for both field and source, but owing to the nonlinearity of the theory these two concepts have not hitherto been related. Recently Sciama, Waylen and Gilman (1969) have found a pseudo-linear integral representation of Einstein's field equations. This representation is used to find a relation between the multipole moments of field and source in the static case. The technique is to expand the Green's function of the representation in a series of eigenfunctions of an associated linear differential operator. (auth)

34729 GRAVITATIONAL FIELD ACTING AS AN OPTICAL MEDIUM. de Felice, Fernando (Univ., Padua). Gen. Relativity Gravitation; 2: No. 4, 347-57(1971).

Given a curved space-time with a metric tensor g_{ij}, Maxwell's equations may be written as if they were valid in a flat space-time in which there is an optical medium with a constitutive equation. When optical phenomena are considered, this medium turns out to be equivalent to the gravitational field. Optical phenomena in various gravitational fields are analyzed, and it is found that the language of classical optics for the "equivalent medium" is as suitable as that of Riemannian geometry. (auth)

34730 C^∞ SOLUTIONS OF HYPERBOLIC NONLINEAR EQUATIONS APPLICATIONS IN G.R.G. Choquet-Bruhat, Yvonne (Univ., Rome). Gen. Relativity Gravitation; 2: No. 4, 359-62 (1971).

It is shown that for any hyperbolic, quasi-linear system of partial differential equations, with diagonal principal part, C^∞ coefficients and C^∞ Cauchy datas, the solution is C^∞ in all the domain of existence Ω_{μ_0}, of a solution in H_{μ_0} where H_{μ_0} is the minimum Sobolev class necessary to prove the existence of a solution if the coefficients of the highest order, m, of the unknowns contain only the derivatives of order $m - 2$ of these unknown (case of Einstein's equations in vacuum) in the general case the solution is C^∞ in Ω_{μ_0+1}. (auth)

34731 GRAVITATIONAL FIELD OF A MASSLESS PARTICLE. Aichelburg, P. C.; Sexl, R. U. (Univ., Vienna). Gen. Relativity Gravitation; 2: No. 4, 303-12(1971).

The gravitational field of a massless point particle is first calculated using the linearized field equations. The result is identical with the exact solution, obtained from the Schwarzschild metric by means of a singular Lorentz transformation. The gravitational field of the particle is nonvanishing only on a plane containing the particle and orthogonal to the direction of motion. On this plane the Riemann tensor has a δ-like singularity and is exactly of Petrov type N. (auth)

34732 MEANING OF THE EINSTEIN- AND THE LORENTZ-COVARIANT DERIVATION. Treder, Hans-Juergen (Deutsche Akademie der Wissenschaften, Berlin). Gen. Relativity Gravitation; 2: No. 4, 313-19(1971).

A derivation operation working on hybrid objects which are tensors under the Einstein group of coordinate transformations and under the Lorentz group of transformations of reference systems are defined. With these general covariant derivations the principle of the equivalence of the Einstein- and of the Lorentz-covariant representations of the physical laws are formulated. This principle means the general covariant constance of the metric tetrads h_i^A (Weyl's lemma). (UK)

34733 DATTA'S SPHERICALLY SYMMETRIC SYSTEMS IN GENERAL RELATIVITY. Bondi, Hermann (ESRO, Paris). Gen. Relativity Gravitation; 2: No. 4, 321-9(1971).

The problem tackled by B. K. Datta, in a recent paper (1970) concerning nonstatic spherically symmetric systems in which the particle motion is, in a certain sense, purely transverse, is further developed and compared with the Newtonian case. A full classification of the possible motions is given. (auth)

34734 SPHERICALLY SYMMETRIC PERFECT FLUID DISTRIBUTIONS AND CLASS ONE PROPERTY. Rao, J. Krishna (Gujarat Univ., Ahmedabad, India). Gen. Relativity Gravitation; 2: No. 4, 385-6(1971).

It is shown that for a spherically symmetric perfect fluid solution to be of class one, either $\epsilon = 0$, or $\epsilon + R = 0$, ϵ and R being respectively the eigenvalue of the Weyl tensor in Petrov's classification and spur of the Ricci tensor. Hence, it is deduced that whereas every conformally flat perfect fluid solution is of class one, the converse is not true in general. However, the converse does hold for all solutions with $\rho = 3p$. (auth)

34735 UNIVERSE EMBEDDED IN A FIVE-DIMENSIONAL FLAT SPACE. Goldman, Itzhak; Rosen, Nathan (Technion-Israel Inst. of Tech., Haifa). Gen. Relativity Gravitation; 2: No. 4, 367-84(1971).

Since a homogeneous isotropic universe can be embedded in a flat space of five dimensions, the question is considered under what conditions a more general universe can be embedded in a five-dimensional flat space. On the assumption that the deviation from homogeneity is small, it is found that real inhomogeneities can occur only in the case of a universe filled with radiation, or a universe containing at least two different substances with different equations of state, as for example radiation and matter. In the case of a radiation-filled universe, the inhomogeneities can be of arbitrary size and can conceivably be the precursors of galaxies. (auth)

34736 SANDWICH DATA LEADING TO ELLIPTIC EQUATIONS. Bergmann, Peter G. (Syracuse Univ., N. Y.). Gen. Relativity Gravitation; 2: No. 4, 363-6(1971).

It is shown that a large class of conformal transformations of the metric tensor on a three-dimensional space-like hypersurface leads to sandwich problems that result in elliptic differential equations for the unknown variables. (auth)

34737 TEST OF THE FLUCTUATION–REGRESSION HYPOTHESIS. Bernstein, Morton Mark. New York, N. Y.; New York Univ. (1971). 83p. University Microfilms Order No. 72-13,337.

Thesis.

A test of the fluctuation-regression hypothesis of Onsager is made on a one-dimensional system of hard rods of diameter, a. The fluctuation-regression hypothesis assumes that the time history of a macroscopic variable in a thermodynamic system (N and L approaching infinity such that the ratio N/L = n, remains finite) relaxing from a given initial state of equilibrium in a finite field (gravitational, for example) is identical to the time history of the same macroscopic variable relaxing from the same initial state which has been synthesized by a combination of single particle fluctuations. Two potentials are considered: the gravitational potential and an arbitrary potential which decreases with distance from the origin. It is found, as in the case of the gravitational potential, that the "current density" does not vanish with the field strength as the fluctuations regress. The fluctuation-regression hypothesis does not seem to hold in a one-dimensional system of hard rods for the two types of potentials considered. (Diss. Abstr. Int., B)

34738 CONSERVATION OF THE NEWMAN–PENROSE CONSERVED QUANTITIES. Goldberg, Joshua N. (Syracuse Univ., N. Y.). Phys. Rev. Lett.; 28: No. 21, 1400-2(22 May 1972).

Using an example of Press and Bardeen, Newman–Penrose quantities of the electromagnetic field in a Schwarzschild background are related to a differential conservation law and hence changes result from a flux. There is no discontinuity in the quantities resulting from a sudden change in dipole moment; there is no singular surface which moves out at ⅓ the speed of light. It is suggested that for Newman–Penrose quantities to exist, multipole moments must approach a limit as $1/u$, $u \rightarrow -\infty$. (auth)

34739 IDEAL POINTS IN SPACE–TIME. Geroch, R. (Syracuse Univ., N. Y.). Proc. Roy. Soc. (London), Ser. A; 327: No. 1571, 545-67(25 Apr 1972).

A prescription is given for attaching to a space–time M, subject only to a causality condition, a collection of additional "ideal points." Some of these represent "points at infinity", others "singular points." In particular, for asymptotically simple space–times, the ideal points can be interpreted as the boundary at conformal infinity. The construction is based entirely on the causal structure of M, and so leads to the introduction of ideal points also in a broad class of causal spaces. It is shown that domains of dependence can be characterized in terms of ideal points, and this makes possible an extension of the domain-of-dependence concept to causal spaces. A suggestion is made for assigning a topology to M together with its ideal points. This specifies some singular-point structure for a wide range of possible space–times. (auth)

34740 GRAVITATIONAL QUADRUPOLE RADIATION. Keres, Piret; Unt, V. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 21: No. 1, 3-16 (1972). (In Russian).

A technique for integrating the Einstein equations by the succesive approximation method and separation of variables is worked out. The method is applied in the case of gravitational quadrupole radiation. A detailed analysis of the second approximation is given. (auth)

34741 TAILS OF THE WAVES IN THE SCHWARZSCHILD FIELD. Unt, V.; Keres, Piret (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat.; 21: No. 1, 17-30(1972). (In Russian).

The waves in the Schwarzschild field are considered. The scattering of the waves on the curvature of space-time is investigated. A perturbation method is used, and calculations are carried out to the third order. The integration of electromagnetic and gravitational radiation is reduced to the integration of the scalar wave equation. (auth)

34742 INTERPRETATION OF EINSTEIN'S HERMITE-SYMMETRIC FIELD THEORY. Treder, H.-J. (Deutsche Akademie der Wissenschaften, Berlin). Tensor; 23: No. 1, 75-80(Jan 1972). (In German).

The Hermite generalization of Riemann's geometry to Einstein's relativistic theory is analyzed. The irreducibility of the field equations resulting from the postulate of Hermite symmetry are discussed; analogies to the quantum theory in which not real symmetrical but complex Hermite operators are applied; the introduction of a material tensor of Hermite symmetry; and the unequivocal transition to Einstein's relativistic theory of gravitation. (H.B.G.)

Scattering Theory

34743 (COO–3130–TA–259) DIAGONALIZATION OF INCLUSIVE SUM RULES AND INCLUSIVE BOOTSTRAP. Mak, Se-Yuen; Tan, Chung-I (Brown Univ., Providence, R. I. Dept. of Physics). [1972]. 17p. Dep. NTIS.

The technique of multi-dimensional Laplace transforms under which the inclusive-like sum rules for discontinuities of multiparticle amplitudes can be diagonalized is introduced. The resulting equations are simple constraints on the generalized partial-wave amplitudes, and they can be used to impose unitarity conditions for bootstrap models. A simple example is given to illustrate the nonlinear nature of this "inclusive bootstrap" program. (auth)

34744 (ITF–71-102-E) IMPROVEMENT ON THE APPROXIMATIONS FOR THE AMPLITUDE OF SCATTERING BY SINGULAR POTENTIALS. Guliy, V. N. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 11p. Dep. NTIS (U. S. Sales Only).

The partial wave Schroedinger equation for an arbitrary singular potential is reduced to an interable integral Volterra equation in which the problem of the turning point of any order is solved. As distinct from the Lomsadze method proposed previously the method allows one to effectively calculate the amplitude for the physical values of parameters. The expression for the phase shift in zero approximation is analogous to that obtained previously by other authors. (auth)

34745 (JINR–P2-6347) LOCAL QUASIPOTENTIAL IN THE RELATIVISTIC THREE-BODY PROBLEM. Kvinikhidze, A. N.; Stoyanov, D. Ts. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

The possibility of using the quasipotential, which is local in the pair-interaction approximation, in the three-particle relativistic three-dimensional equations is discussed. It is shown that the part of this quasipotential corresponding to the pair-interaction can be expressed by two-particle physical on-shell amplitudes (decomposition in powers of the weak coupling constant is unnecessary). It is proved that all 16 amplitudes obtained as the solutions of these equations on the mass-shell coincide with the correct physical amplitudes. (auth)

34746 RELATIVISTIC THREE-BODY PROBLEM IN TERMS OF THREE-DIMENSIONAL VARIABLES. Kvinikhidze, A. N.; Stoyanov, D. Ts. (Tbilisi State Univ., USSR. Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 11: No. 1, 23-36(Apr 1972). (In Russian).

Using the retarded part of the two-time three-particle Green function, the equations are deduced which determine relativistic amplitudes of all the 16 possible transitions in the three-body system. These equations do not include relative energies and are the direct relativistic generalization of the Faddeev equations. The equation for the relativistic analog of the three-particle bound-state wave function is also obtained. (auth)

34747 INVERSE PROBLEM OF POTENTIAL SCATTERING ACCORDING TO THE KLEIN–GORDON EQUATION. Weiss, R.; Scharf, G. (Univ., Zurich). Helv. Phys. Acta; 44: No. 7, 910-29(31 Dec 1971).

The inverse problem of constructing a spherically symmetric potential from its scattering data is solved for the Klein–Gordon equation, following the approach of Marchenko for the Schrödinger equation. This theory is well suited for the application to actual scattering processes. The interaction potential can be calculated uniquely from the scattering phase shift and the bound state data. (auth)

34748 QUANTUM-MECHANICAL IMPACT PARAMETER OPERATOR. McDonald, S. C. (Univ. of Liverpool). Nuovo Cim.; 9B: No. 1, 111-21(11 May 1972).

A quantum-mechanical representation of the impact parameter which is manifestly compatible with the correspondence principle is discussed. Its high-energy limit is considered with respect to the impact parameter variable of the eikonal approximation, and at finite energies the impact parameter is interpreted within the context of the Regge representation. (auth)

34749 OPTIMISED INTEGRAL CONTINUATION METHODS. Ross, G. G. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; B41: No. 1, 272-84(1972).

The problem of finding the analytic function which minimizes the difference between it and information about the function on the boundary weighted according to the accuracy to which the function is known. A representation of the function is found in the form of an integral over the boundary involving the function boundary values and errors. Applications involving continuation throughout the analyticity region and, in particular, to the boundary are investigated. Optimized relations are derived for the determination of Regge-pole parameters from low-energy information and also for the determination of pole residues. In each case realistic statistical errors are given. (auth)

34750 SCATTERING THEORY IN THREE-BODY KINETIC EQUATIONS. Lowry, John T.; Schieve, William C. (Univ. of Texas, Austin). Transp. Theory Statist. Phys.; 1: No. 3, 225-38(1971).

The relation between the collision kernel of the three-body quantum mechanical kinetic equation (quantum version of the Choh-Uhlenbeck equation) and modern scattering theory is examined utilizing the work of Faddeev and Weinberg. Recognizing that the collision kernel is related to the Møller scattering operator it is shown that the collision kernel is "well-defined" for suitable interaction potentials and contains only connected three particle collisions in the sense of Weinberg. The collision kernel is interpreted physically and is shown to contain a generalization of the ordinary Boltzmann collision term to three particle processes plus a distorted-wave-impulse approximation correction to the two particle Boltzmann collision term. (auth)

34751 STRUCTURE OF DUAL RESONANCE LOOP AMPLITUDES IN TERMS OF THE MANDELSTAM VARIABLES s_{ij}. Karpf, A. D. (Univ., Freiburg i. B.). Nucl. Phys.; B41: No. 2, 591-99(1972).

For further investigations of the dual resonance loop amplitude of Lovelace and Alessandrini, such as high energy behavior and l-plane analyticity, it is indispensable to write it down in terms of the Mandelstam variables s_{ij}. It is shown that this form is very similar to the N-particle Veneziano amplitude by making use of some very interesting relations of exp (Re Ω). It is shown that these terms have properties just like the respective cross-ratios in the N-particle Veneziano amplitude. (auth)

34752 ESSENTIAL SELF-ADJOINTNESS FOR HIGHLY SINGULAR POTENTIALS. Masson, D.; Stevens, L. (Univ. of Toronto). Nucl. Phys.; B41: No. 2, 600-4(1972).

The essential self-adjointness of the Hamiltonian operator associated with non-spherically symmetric potentials which are highly singular and repulsive at the origin is proved. (auth)

34753 ALGEBRAIZATION OF REGGE COUPLINGS. Kleinert, H. (CERN, Geneva. Freie Univ., Berlin). Phys. Lett.; 39B: No. 4, 511-13(15 May 1972).

In any finite saturation scheme of the SU(2) × SU(2) algebra at infinite momentum the mass^2 operator is known to consist of an SU(2) × SU(2) singlet and a fourth component of a $(\frac{1}{2}\frac{1}{2})$ representation (m_a^2, m_4^2). It is shown that m_4^2 and $[m_a^2, m_b^2]$ represent directly the Regge couplings of f and ρ trajectories in the scattering amplitudes $\pi_a\alpha \rightarrow \pi_b\beta$ at $t = 0$. (auth)

PHYSICS (LOW-TEMPERATURE)

Superfluidity

34754 LANDAU PARAMETERS IN HELIUM II. Donnelly, R. J. (Univ. of Oregon, Eugene). Phys. Lett.; 39A: No. 3, 221-2(8 May 1972).

Simple relations are given expressing the pressure and temperature dependence of the Landau parameters for rotons in liquid helium II. (auth)

34755 THERMAL EXPANSION OF LIQUID ^{4}He BETWEEN 0.1 AND 0.7 K. Roach, P. R.; Ketterson, J. B.; Abraham, B. M.; Kuchnir, M. (Argonne National Lab., Ill.). Phys. Lett.; 39A: No. 3, 251-2(8 May 1972).

The thermal expansion of liquid ^{4}He from 0.1 to 0.7 K was determined by comparing the temperature dependence of the constant-density and the constant-pressure sound velocities. The agreement with the theoretical phonon contribution is very good. (auth)

34756 SUPERFLUID DENSITY NEAR THE LAMBDA POINT IN ^{4}He UNDER PRESSURE. Terui, G.; Ikushima, A. (Tokyo Univ.). Phys. Lett.; 39A: No. 3, 161-2(8 May 1972).

The superfluid density was deduced from the second-sound velocity near the λ point of ^{4}He as functions of $T_\lambda - T$ and pressure. The critical exponent was found to increase slightly with increasing pressure. (auth)

34757 ONSET OF TURBULENCE FOR COUNTERFLOW IN He II. Spangler, Glenn E. (Army Mobility Equipment Research and Development Center, Fort Belvoir, Virginia). Phys. Rev., A; 5: No. 6, 2587-94(Jun 1972).

Two mutual friction numbers are derived for superfluid helium which can describe the onset of turbulence in counterflowing helium. The numbers are $M_n = A\rho_s\rho_n \langle \vec{V}_r \rangle^3 d^2/\eta_n \langle \vec{V}_n \rangle$ and $M_s = A\rho_s\rho_n \langle \vec{V}_{\cdot} \rangle^3 d^2/\eta_n \langle \vec{V}_s \rangle$, where M_n predicts the onset of turbulence in the normal fluid and M_s predicts the onset of turbulence in the superfluid. Staas, Taconis, and van Alphen's Reynolds number is found to apply only to flow conditions for which $\vec{V}_n \simeq \vec{V}_s$. (auth)

34758 MOTION OF CHARGE CARRIERS IN NORMAL ^{4}He. Ostermeier, R. M.; Schwarz, K. W. (Univ. of Chicago). Phys. Rev., A; 5: No. 6, 2510-19(Jun 1972).

Values for the mobilities of positive and negative charge carriers in normal ^{4}He at the vapor pressure are presented. The interpretation of these measurements in terms of the usual microscopic models for the charge carriers is shown to require the correct hydrodynamic treatment of a modified Stokes-flow problem. Good agreement with experiment is found for both μ_+ and μ_- below 4.2°K, and new information is obtained about several features of the carrier structures. The behavior of μ_+ and μ_- above 4.2°K suggests the possibility that the viscosity of normal helium has a peculiar temperature dependence in this range. Sudden drops in μ_+ and μ_- are observed near the critical temperature, and it is argued that this kind of effect may be due to critical-point fluctuations rather than to changes in carrier structure as has been claimed by other authors. (28 references) (auth)

34759 SECOND-SOUND VELOCITY, SCALING, AND UNIVERSALITY IN He II UNDER PRESSURE NEAR THE SUPERFLUID TRANSITION. Greywall, Dennis S.; Ahlers, Guenter (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 28: No. 19, 1251-4(8 May 1972).

The velocity of second sound in He II was measured for $\epsilon \equiv 1 - T/T_\lambda \geq 2 \times 10^{-5}$ between saturated vapor pressure (SVP) and the melting curve. For P > SVP, the corresponding superfluid fraction ρ_s/ρ' cannot be described by a simple power law in ϵ. When reasonable general assumptions are made about higher-order singular contributions, the asymptotic behavior of ρ_s/ρ may be deduced and agrees well with scaling and universality. (auth)

34760 INTERPRETATION OF INELASTIC NEUTRON-SCATTERING OBSERVATIONS IN bcc SOLID AND SUPERFLUID ^{4}He. Werthamer, N. R. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 28: No. 17, 1102-5(24 Apr 1972).

Recent inelastic neutron scattering observations on the bcc phase of solid ^{4}He are interpreted as showing (i) substantial interference between the one-phonon peak and the multiphonon background, due to strong phonon interaction processes; and (ii) a Debye–Waller factor, extracted by use of first-moment sum rules, which closely resembles the structure of superfluid ^{4}He. Implications of this resemblance for the ground-state wave functions of crystalline and superfluid helium are discussed. (auth)

34761 VELOCITY OPERATOR FOR MANY-BOSON SYSTEMS. Turski, L. A. (Univ., Warsaw). Physica; 57: No. 3, 432-44 (1 Feb 1972).

Beginning with Landau's theory of superfluid systems various attempts were made to formulate the theory of many-boson systems in terms of hydrodynamical quantities, i.e., particle density and velocity fields. A new approach is proposed to this question based on the application of Glauber's (or coherent states) representation. The general form of the velocity operator is derived and special attention is paid to the properties of the velocity field in superfluid systems. The relation between the present approach and the one known previously is discussed. (auth)

34762 BOUND STATES OF EXCITATIONS IN A BOSE SYSTEM WITH A CONDENSATE. Nepomnyashchii, Y. U. (Perm State Univ., USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 4, 146-9(20 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 4, 211-15(20 Feb 1972).

A theory is constructed of bound states of elementary excitations in liquid ^{4}He or, in general, in a homogeneous Bose system with a condensate. The theory shows that the condensate plays a unique role that makes it necessary to review the usual correspondence between bound states and the poles of multiparticle Green's functions. This makes it possible, in particular, to explain why the branch observed in experiments with Raman scattering and characterizing the bound state of two rotons with nonzero angular momentum $l = 2$ does not appear with any degree of clarity in experiments with neutron scattering. The theory employs the Green's-function method and the Feynman diagram technique, but no reference is made to perturbation theory at all. (M.H.R.)

34763 THERMAL BOUNDARY CONDUCTANCE BETWEEN SOLIDS WITH IMPURE SURFACES AND SUPERFLUID LIQUID HELIUM II. Hesser, R. J.; Chapman, R. C.; Change, Y. W.; Frederking, T. H. K. (Univ. of California, Los Angeles). Chem. Eng. Progr., Symp. Ser.; 66: No. 102, 133-40(1970).

From eleventh national heat transfer conference; Minneapolis, Minn. (3 Aug 1969).

The overall heat transfer coefficients of contaminated, low-conductivity surfaces were studied. The materials utilized were constantan coated with colloidal graphite and lead covered with an oxide layer. The latter was studied in the superconducting state and in the normal state above the critical magnetic field which quenches superconductivity. Consequently, boundary effects due to the electronic state of the solid could be observed. This investigation of the electronic effects made it possible to assess the effects of liquid properties on the boundary conductances at large ΔT values. First, the phonon radiation laws that establish a frame of reference for the discussion of the data are considered. Subsequently, details of the experiment are reported. Finally, the data are discussed and compared with phonon radiation constraints. (auth)

34764 DILUTION REFRIGERATION AND VORTEX RINGS IN ^{3}He–^{4}He MIXTURES. Ryan, Stewart Richard. Ann Arbor, Mich.; Univ. of Michigan (1971). 172p. University Microfilms Order No. 72-14,981.

Thesis.

The construction and operation of a ^{3}He–^{4}He dilution refrigerator are reported in detail. A new susceptibility bridge and a compendium of useful materials and techniques are presented. The friction on positively charged vortex rings in a range of dilute ^{3}He–^{4}He mixtures was measured between 60 and 200 mK. Assuming a hollow core of radius 1.28 Å, the friction coefficient α is independent of temperature above 100 mK and decreases by 5% at 60 mK. Between 40 and 80 ppM of ^{3}He, the friction is proportional to the concentration x, and α/x is equal to 0.037 eV/(cm ppm). There is an apparent decrease in α/x at lower concentrations and a systematic dependence on electric field and ring energy that is not understood. (Diss. Abstr. Int., B)

34765 LINE WIDTH OF ROTONS IN He II ABOVE THE THRESHOLD FOR PHONON EMISSION. Jaeckle, J. (Univ., Geneva); Kehr, K. W. Phys. Lett.; 39A: No. 4, 327-8(22 May 1972).

The phonon emission rate of rotons for which the group velocity equals the sound velocity is calculated. The experimentally observed increase of the line width of these rotons cannot be explained by a simple theory of phonon emission. (auth)

34766 HEAT CAPACITY AT CONSTANT VOLUME NEAR THE SUPERFLUID TRANSITION. Ahlers, G. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Lett.; 39A: No. 4, 335-6(22 May 1972).

Available experimental results for C_v near T_λ are examined for consistency with other thermodynamic measurements and are compared with current theories. (auth)

34767 HYDRODYNAMICS OF CONDENSED BOSE SYSTEMS. Haug, H.; Weiss, K. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett.; 39A: No. 4, 255-6(22 May 1972).

A microscopic theory of superfluidity is developed that is shown to be fully compatible with the phenomenological two-fluid model. The relation obtained between the densities of the condensate and the supercomponent is velocity-dependent and has the correct limiting behavior for T = 0°K and T_λ. (auth)

Superconductivity

Refer also to abstracts 35287, 35288, 35292, and 35293.

34768 (NBS-SPEC. PUBL—323, pp 731-4) VOLUME DEPENDENCE OF THE ELECTRONIC DENSITY OF STATES IN SUPERCONDUCTORS. Boughton, R. I.; Olsen, J. L.; Palmy, C. (Eidgenoessische Technische Hochschule, Zurich (Switzerland). Laboratorium fuer Festokoerperphysik). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

The volume dependence of the electronic specific heat coefficient γ can be obtained from measurements of the low-temperature thermal expansion, from observations on the pressure dependence of the superconducting threshold curve, and from the volume change occurring at transition. Recent theoretical results are used to obtain values of the change in the density of states with volume from the existing experimental data for a number of metals. (auth)

34769 (NBS-SPEC. PUBL—323, pp 735-6) ALLOY FERMI SURFACE TOPOLOGY INFORMATION FROM SUPERCONDUCTIVITY MEASUREMENTS. Kaehn, H. D.; Higgins, R. J. (Oregon Univ., Eugene. Dept. of Physics). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

It was found previously that the rapid variation with concentration of the pressure and strain derivatives of the superconducting transition temperature (dT_c/dp and $dT_c/d\epsilon$) observed in the In—Cd alloy system has a direct connection with the alloy density of states at the Fermi level. Here, important corrections to the dT_c/dp calculation, found in the course of interpreting recently reported $dT_c/d\epsilon$ data on whiskers, are reported. (M.H.R.)

34770 (NBS-SPEC. PUBL—323, pp 767-73) MODEL DENSITY OF STATES FOR HIGH TRANSITION TEMPERATURES BETA-TUNGSTEN SUPERCONDUCTORS. Cohen, R. W.; Cody, G. D.; Vieland, L. J. (RCA Labs., Princeton, N. J.). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

A simple density-of-states model is applied to the problem of superconductivity in high T_c beta-tungsten superconductors. If it is assumed that the interaction responsible for superconductivity is predominately between d-band carriers and acoustic phonons via a deformation potential matrix element, simple analytic expressions for the effective electron—electron coupling constant λ and $T_c(\lambda)$ can be obtained. The quantities λ and T_c can then be estimated using parameters determined from an application of the density-of-states model to the cubic-state elastic constants. The simple condition $\lambda > \Delta_{crit} \approx 0.7$ is established for the existence of a cubic—tetragonal lattice transformation in these materials. Using the result for T_c, $T_c \gtrsim 15$ K is found for all materials that exhibit a lattice transformation. Thus, the relation between high-T_c superconductivity and lattice transformation in the β—W compounds is established. (auth)

34771 NONLOCAL ELECTRODYNAMICS IN A SUPERCONDUCTOR WITH SPACIALLY VARYING GAP PARAMETERS. Brandt, E. H. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Phys. Lett.; 39A: No. 3, 227-8(8 May 1972).

A linear, nonlocal relation between current and vector potential in a superconductor with spatially varying gap is derived. It is shown that the temperature range over which generalized Ginsburg—Landau functionals may be used for clean superconductors is quite narrow. (auth)

34772 MAGNETIC FIELD OF AN ISOLATED FLUX LINE IN A TYPE-II SUPERCONDUCTOR AT FINITE TEMPERATURE. Brandt, E. H. (MPI Metallforschung, Stuttgart). Phys. Lett.; 39A: No. 3, 193-4(8 May 1972).

The exact BCS solution for an isolated vortex shows field reversal at large distances for small κ. (auth)

34773 EFFECT OF SPIN FLUCTUATION IN SUPERCONDUCTORS. Kitamura, Toyoyuki (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 47: No. 3, 765-73(Mar 1972).

Hamann and Kuroda theory on the Anderson model in the nonmagnetic state is extended to superconductors. The transition temperature is investigated in the renormalized random-phase approximation. The equation which determines the transition temperature contains the terms arising from the density and spin fluctuation. The expression for the transition temperature is obtained and analyzed. It is shown that the effect of the spin fluctuation can be important in some cases, compared with the Hartree—Fock approximation. (auth)

34774 EXPERIMENTAL RELATIONSHIP BETWEEN THE SUPERCONDUCTING AND THE FERROELECTRIC PHASE TRANSITIONS. Grassie, A. D. C.; Benyon, A. (Univ. of Sussex, Brighton, Eng.). Phys. Lett.; 39A: No. 3, 199-201(8 May 1972).

The superconducting transition temperatures of locally doped semiconducting alloys were shown to be correlated with the ferroelectric Curie temperatures in these alloys, resulting in an elevation of the superconducting transition temperatures. (auth)

34775 MAGNETIZATION AND SIZE EFFECT OF HARD SUPERCONDUCTORS. Handstein, A. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Phys. Status Solidi (a); 10: No. 2, 425-35(16 Apr 1972).

For cylindrical samples of hard superconductors formulas based upon the theory of Irie and Yamafuji are deduced for a calculation of the irreversible portion of magnetization. It is possible to represent the irreversible magnetization in a simple reduced form. The values of maximum magnetization of specimens of a Nb—64 at.% Ti alloy with different thickness and annealing fit to the straight line $-4\pi M_{max} = 0.45_8 H_{max} + 31.6$. A value $H_{c1} = 58$ Oe was found, and the reversible magnetization curve of this alloy was determined. By these, the irreversible portion of experimental magnetization curves is determined and compared with the calculations. The causes of deviations are discussed. (auth)

34776 SUPERCONDUCTIVITY OF SOLID SOLUTIONS OF RHENIUM WITH MOLYBDENUM CARBIDE. Raub, Ch. J. (Forschungsinstitut fuer Edelmetalle und Metallchemie, Schwaebisch Gmuend, Ger.); Mons, W.; Lawson, A. C. J. Less-Common Metals; 26: No. 2, 319-20(Feb 1972).

Superconductive properties of hcp solid solutions and carbides were investigated. Powder mixtures were sintered at 2000°C and T_c's were determined using a dc mutual inductance bridge and a ballistic galvanometer as a null indicator. The T_c vs composition curve had a maximum (about 5°K at 20% Mo_2C) higher than those of Re—Os and Re—Ru, but lower than that of hcp Re—Mo. There was no correlation between T_c and hardness. (M.C.G.)

34777 ELECTRIC POTENTIALS NEAR A SUPERCONDUCTING—NORMAL BOUNDARY. Yu, M. L.; Mercereau, J. E. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 28: No. 17, 1117-20(24 Apr 1972).

Measurements were made within a few micrometers of a current-carrying superconducting/normal boundary, which indicate that an electric potential exists in the superconductor in this region. Near the transition temperature the experimental results are consistent in magnitude and temperature dependence with a theory recently proposed by Rieger, Scalapino, and Mercereau. (auth)

34778 PRESSURE-INDUCED ELECTRON TRANSITION IN $AuGa_2$. Schirber, J. E. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett.; 28: No. 17, 1127-9(24 Apr 1972).

Measurements are reported of a large, nearly discontinuous change in the superconducting transition temperature of $AuGa_2$

near 6 kbar as predicted earlier from pressure measurements of cross-sectional areas of the Fermi surface. This is interpreted as strong evidence for a pressure-induced electron transition near 6 kbar at liquid-He temperatures. (auth)

34779 EXPERIMENTAL OBSERVATION OF PAIR—QUASIPARTICLE POTENTIAL DIFFERENCE IN NONEQUILIBRIUM SUPERCONDUCTORS. Clarke, John (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 21, 1363-6(22 May 1972).

It is shown experimentally that when a quasi-particle current is converted into a pair current in a superconductor, the quasi-particle potential in the nonequilibrium region differs from the pair chemical potential. (auth)

34780 THEORY OF PAIR—QUASIPARTICLE POTENTIAL DIFFERENCE IN NONEQUILIBRIUM SUPERCONDUCTORS. Tinkham, M.; Clarke, John (Cambridge Univ., Eng.). Phys. Rev. Lett.; 28: No. 21, 1366-9(22 May 1972).

A theory is given of the observable potential difference between pairs and quasi-particles due to the imbalance in the populations of the electron-like and hole-like branches of the excitation spectrum of a superconductor, caused by injection of a quasi-particle current. (auth)

34781 OBSERVATION OF A SINGLE CRYSTAL OF VORTEX LINES IN A TYPE-II SUPERCONDUCTOR. Cribier, D. (CEN de Saclay, Gif-sur-Yvette, France); Simon, Y.; Thorel, P. Phys. Rev. Lett.; 28: No. 21, 1370-2(22 May 1972).

A quasi-perfect crystal of vortex lines was observed by neutron diffraction. The quality of the crystal allows the direct detection and measurement of the relative intensities at the Bragg peaks [10], [20], and [11] (in the reciprocal space of the two-dimensional lattice) and gives, for the first time, the possibility of mapping the magnetic field of the mixed state. (auth)

34782 HIGH-FREQUENCY MAGNETIC POLARIZABILITY OF SMALL SUPERCONDUCTING TIN PARTICLES. Naumenko, I. G.; Petinov, V. I.; Gen, M. Ya. (Inst. of Chemical Physics, Chernogolovka, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2740-4(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3260-5(Nov 1971).

The high-frequency polarizability was studied for superconducting spherical tin particles with radii of 1.75×10^{-5} and 0.8×10^{-5} cm at 9.4 GHz. The relations $\alpha'(T)$, $\alpha''(T)$, and $\alpha'(H)$, $\alpha''(H)$ were determined. The relations found for $\alpha'(H)$ and $\alpha''(H)$ have hysteresis. For small H, $\alpha''(H)$ is observed to decrease with increasing field. The temperature dependences of H_1 and H_2 and the minimum value of $\alpha''(H)$ are given for both particle sizes. The experimental results are discussed within the framework of the existing theory. (auth)

34783 JOSEPHSON EFFECT. Kose, V.; Fack, H.; Gutmann, P. (Physikalisch-Technische Bundesanstalt, Brunswick). PTB Mitt.; 82: No. 1, 1-4(Feb 1972). (In German).

The electrical properties of the Josephson effect are demonstrated by an emission and an absorption experiment. The importance of this new superconducting phenomenon for metrology will be discussed. (auth)

34784 HIGH-TEMPERATURE SUPERCONDUCTORS: THE FIRST TERNARY SYSTEM. Matthias, B. T.; Marezio, M.; Corenzwit, E.; Cooper, A. S.; Barz, H. E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Science; 175: No. 4029, 1465-6(31 Mar 1972).

A new system of high-temperature superconductors is reported. The compounds, $Mo_{6-x}A_xS_6$ where A is Cu, Zn, Mg, Ag, Cd, Sn, or Pb, are rhombohedral with $a \simeq 6.5$Å and $\alpha \sim 90°$. The transition temperatures range from ~2.5°K for the Cd compound to ~13°K for the Pb compound. (auth)

34785 FERMI SURFACE OF LEAD AT NORMAL AND HIGH PRESSURE. Anderson, J. R. (Univ. of Maryland, College Park); O'Sullivan, W. J.; Schirber, J. E. Phys. Rev., B; 5: No. 12, 4683-92(15 Jun 1972).

The pressure dependence of the Fermi surface of lead was studied by means of NMR-calibrated de Haas—van Alphen-effect measurements. In order to carry out these investigations, the values of Fermi-surface areas, obtained from pulsed-magnetic-field measurements, were redetermined to correct for a calibration error. Attempts to fit the measurements with a local model potential were not completely successful, but a nonlocal calculation based on the Heine—Abarenkov model potential gave satisfactory agreement with the experimental results. (auth)

34786 ALLOYS AND THEIR PRODUCTION. (to Siemens Aktiengesellschaft). British Patent 1,268,425. 29 Mar 1972. Priority date 30 Nov 1968, Germany.

A process is given for producing easily fabricated superconductors of the composition $V_xGa_yAl_z$ alloys, where $68 \leq x \leq 87$, $5 \leq y \leq 31$, and $1 \leq z \leq 22$. In this process, the elements are fused together, solidified in the A2 phase, cooled rapidly, mechanically worked, and then tempered above 700°C to convert the ductile A2 phase into the superconducting A15 phase. Addition of B and C up to 10 at. % increases the critical current densities. Several examples of the process and the resulting superconducting properties are given. (D.L.C.)

34787 SUPERCONDUCTIVITY AND ELECTRONIC PROPERTIES OF Mg—Cd AND SOME hcp Mg ALLOYS. Bucher, E.; Heine, V.; Andres, K.; Maita, J. P.; Cooper, A. S. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 6: No. 1, 103-10(1 Jul 1972).

The superconducting transition temperature T_c, electronic specific heat γ, and Debye temperature Θ were measured in the Mg—Cd alloy system and in some other Mg-rich hcp alloys. No superconductivity could be detected in the latter above 0.013°K. On the Cd-rich side of the Cd—Mg system, T_c drops rapidly on alloying with Mg, and if one correlates this with the drop in c/a, one may expect Mg to have T_c around 1×10^{-4}°K. A subsidiary maximum in T_c occurs at x = 0.20 (in Mg_xCd_{1-x}), where γ and Θ have a marked maximum and minimum, respectively. At x = 0.50, the γ has a minimum and Θ has a maximum if the mass factor is divided out. The possible origin of the anomaly at x = 0.20 is discussed in terms of ordering and an incipient instability reflected in the rapid variation of c/a. (auth)

34788 NMR STUDIES OF THE TRANSITION OF NIOBIUM INTO THE SUPERCONDUCTING STATE. Tret'yakov, B. N.; Kuritsin, V. B. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met.; No. 71, 177-80(1969). (In Russian).

Nuclear magnetic resonance with a modulated magnetic field in conjunction with quadrupole moments of the nuclei under investigation provide quantitative information concerning the kinetics of superconducting transition phenomena. The transition in Nb occurs primarily with distortions in the crystal lattice. Near the critical temperature below 6.5°K the amount of normal phase decreases linearly with a lowering of the temperature. (K.S.W.)

34789 SUPERCONDUCTIVITY AND LATTICE INSTABILITIES OF HfV_2. Lawson, Andrew Cowper. San Diego, Calif.; Univ. of California (1972). 71p. University Microfilms Order No. 72-14,685.

Thesis.

HfV_2 has the highest superconducting transition temperature of all the binary cubic Laves phases. It is shown that this superconductor undergoes a cubic—orthorhombic transition at 118°K. The effect of alloying on crystal structure, superconductivity, and the lattice transition is discussed, and it is shown that this superconductor is also unstable with respect to changes in electron concentration. It is observed that hydrostatic pressure produces large increases in the superconducting transition temperature, and mention is made of preliminary results indicating a pressure-induced instability. (Diss. Abstr. Int., B)

34790 HIGHER-ORDER CORRECTIONS DUE TO THE ORDER PARAMETER TO THE FLUX-FLOW CONDUCTIVITY OF DIRTY, TYPE-II SUPERCONDUCTORS. Takayama, Hajime (Tokyo Univ.); Maki, Kazumi. Phys. Rev. Lett.; 28: No. 22, 1445-8(29 May 1972).

The higher-order corrections in $\Delta(\vec{r})$, the superconducting order parameter, to the flux-flow conductivity of dirty, type-II superconductors are studied theoretically. It is shown that the Thompson term (i.e., the anomalous term) in the flux-flow conductivity is extremely sensitive to the higher-order corrections and decreases rapidly in the vortex state, while the Caroli—Maki term is affected only slightly by the higher-order corrections. (auth)

34791 THEORY OF SURFACE ENERGIES IN PURE SUPERCONDUCTORS. Hu, Chia-ren (Univ. of Southern California, Los Angeles). Phys. Rev., B; 6: No. 1, 1-18(1 Jul 1972).

The WKBJ variational scheme developed by Bardeen et al. which simplifies the Bogolyubov theory for inhomogeneous superconducting states was applied to study normal—superconducting phase boundaries in pure metals. The surface energy of a planar phase boundary at absolute-zero temperature is found for various values of the Ginzburg—Landau parameter. The order parameter and the magnetic field are also determined in this variational procedure.

The present theory differs from the existing ones in its being microscopic and nonlocal, but the nonlocality of our theory is found to have small, though not negligible, effects. Near the transition temperature the free-energy expression for planar phase boundaries is examined by an asymptotic expansion method. (auth)

34792 DYNAMIC STRUCTURE OF VORTICES IN SUPERCONDUCTORS. II. $H \ll H_{c2}$. Hu, Chia-ren; Thompson, Richard S. (Univ. of Southern California, Los Angeles). Phys. Rev., B; 6: No. 1, 110-20(1 Jul 1972).

The time-dependent Ginzburg–Landau equations applicable to a gapless superconductor containing a high concentration of paramagnetic impurities are solved to find the field and charge distributions around an isolated vortex moving in a transport current. The initial slope of the flux-flow resistance with respect to the average magnetic field is found to be approximately $\frac{1}{3}$ the normal resistance divided by H_{c2}. A backflow current is generated for all physical values of the parameters, vanishing only for a special case not possible for this system. (auth)

34793 THERMAL EFFECTS AT SUPERCONDUCTING POINT CONTACTS. Iwanyshyn, O.; Smith, H. J. T. (Univ. of Waterloo, Ont.). Phys. Rev., B; 6: No. 1, 120-30(1 Jul 1972).

I–V curves of superconducting weak-link constriction junctions were calculated by assuming that there is a region of normal material that tends to spread with increasing power levels. The causes for the spreading of the normal resistance are twofold. One is the increase of the current-density distribution and the other is the increase of localized Joule heating at the contact as the total current is increased. The resultant rise in temperature of the link above the bath temperature, over the range of the I–V characteristic, is found to be significant. Using material constants that are representative of bulk Nb, it was found that the calculated I–V characteristic is very similar to several experimentally observed Nb point-contact curves. The spreading normal-resistance analysis has suggested a model to explain the I–V characteristic of a superconductor normal-metal (S/N) point-contact system. A calculation has indicated that large excess temperatures are also present at the contacts when biased in the millivolt region. These findings prompted the review of several published experiments with S/N contacts. (auth)

34794 NONLINEAR PROPERTIES OF FLUXOIDS IN SUPERCONDUCTORS IN A HIGH-SPEED FLUX-FLOW STATE. Sugahara, Masanori (Yokahama National Univ., Japan). Phys. Rev., B; 6: No. 1, 130-6(1 Jul 1972).

The order-parameter variation and the electric current about the normal core of a fluxoid in high-speed motion in clean superconductors in the low-magnetic-field and low-temperature region are discussed on the basis of a time-dependent Ginzburg–Landau equation and a classical equation of motion for the core electrons. It is found that the normal current flow along the core electric field tends to a constant when the fluxoid velocity exceeds $(\xi_0/\tau)(1 + \omega_c^2\tau^2)$, where ξ_0 is the coherence length, τ is the transport relaxation time, and ω_c is the cyclotron frequency. Expressions of the strain field associated with high-speed fluxoids are derived by the use of a modified elastic-wave equation with superconductivity parameters and are used to investigate the fluxoid velocity dependence of the flux-pinning effect. It is shown that the supersonically accelerated fluxoids radiate elastic shock wave, and that flux pinning by internal strain sources like dislocations is expected to disappear. A wave radiation and lowering of the pinning are also found when fluxoids are subjected to a high-frequency vibration. (auth)

34795 ELECTRON-TUNNELING STUDIES OF DILUTE Pb-BASED IN ALLOYS. Sood, B. R. (Case Western Reserve Univ., Cleveland). Phys. Rev., B; 6: No. 1, 136-43(1 Jul 1972).

The technique of electron tunneling was used to obtain the effective phonon spectra, $\alpha^2(w)F(w)$, and the parameters defining the superconductivity for dilute Pb–In alloys by solving the Eliashberg equations. These quantities were extracted from the measured energy gap of the alloy films and the measured normalized conductance of the thin-film tunnel junctions of the form $Al/Al_2O_3/Pb/In$. All the measurements were carried out around 1 K, at which temperature both the aluminum and the alloy films were in the superconducting state. The normal-state data were taken by raising the temperature above the transition temperature of both the films. A band of frequencies, the so-called impurity band, appeared beyond the high-frequency cutoff of the phonon spectrum of pure Pb. For all the alloys studied the impurity band was found to consist of at least two peaks which are attributed to the vibrations of isolated indium atoms and the vibrations of the pairs of indium atoms, both surrounded by the host lead atoms. The position of the first peak has been found to be constant (9.57 ± 0.03 MeV), and its width has been found to vary linearly with concentration of indium. The position of the second peak remains constant up to 2-at. % indium but increases with the further addition of indium. The width of the second peak also varies linearly with the indium concentration. The fraction of modes in the impurity band has been found to be a factor 1.5 to 2.0 less than the concentration of indium. A determination of the ratio of the energy gap to the superconducting transition temperature for the alloy films shows that the electron–phonon interaction remains nearly constant for all the alloys studied. (auth)

34796 TRANSPORT PROPERTIES OF A DIRTY TWO-BAND SUPERCONDUCTOR IN THE MIXED STATE NEAR H_{c2}. Tang, I-ming (American Univ., Beirut, Lebanon). Phys. Rev., B; 6: No. 1, 172-7(1 Jul 1972).

The mixed-state ultrasonic-attenuation and thermal-conductivity coefficients are obtained for a transition-metal superconductor containing a high concentration of nonmagnetic impurities. Expressing the transport coefficients as the sums of correlation functions of the individual bands, the attenuation and thermal-conductivity coefficients are obtained by the use of an equivalence theorem due to Maki. The resulting two-band expressions exhibit the linear field dependences observed in dirty transition-metal superconductors in the gapless state near H_{c2}. The two-band mixed-state thermal-conductivity coefficient for a dirty superconductor is then used qualitatively to show why the slope of the normalized thermal conductivity minus 1 versus the applied field for two dirty transition-metal superconductors ($Nb_{80}Mo_{20}$ and $Nb_{85}Mo_{15}$) having only slightly different l/ξ_0 ratios agrees with the one-band mixed-state thermal-conductivity expression of Caroli and Cyrot for the case of the dirtier $Nb_{80}Mo_{20}$ specimen, while for the case of the $Nb_{85}Mo_{15}$ specimen the slope is much greater than that predicted by the one-band expression. (auth)

34797 FLUCTUATION BROADENING OF THE RESISTIVE TRANSITION TO THE SUPERCONDUCTING STATE OF $Nb_{.88}Ti_{.12}N$ THIN FILMS. Schaer, Frederick Michael. Minneapolis; Univ. of Minnesota (1971). 184p. University Microfilm Order No. 72-14,369.

Thesis.

Measurements of resistance of short mean free path $Nb_{.88}Ti_{.12}N$ thin films are reported. Evidence for fluctuation conductivity is found at temperatures at least twice the 11°K transition temperature. In the upper part of the transition, there is qualitative agreement with the fluctuation conductivity (σ') calculation by Aslamasov and Larkin. (TSS) (Diss. Abstr. Int., B)

34798 EXOTIC IONS IN LIQUID HELIUM. Ihas, Gary Gene. Ann Arbor, Mich.; Univ. of Michigan (1971). 88p. University Microfilms Order No. 72-14,901.

Thesis.

Potassium ions were injected into He II and their mobility was studied. The fractional difference in mobility between this new ion and the normal positive helium ion is measured. The K^+ ion is found to have a mobility a few percent lower than the mobility of the positive helium ion. The fact that the difference is small is consistent with the Atkins model for the ion and the Baym, Barrera, and Pethick mobility theory. A large family of negative carriers in He II is shown to exist. The highest mobility member of this family was first observed by Doake and Gribbon. These charge carriers are created using a glow discharge in the helium vapor above the liquid. The weak-field mobilities of the new charge complexes are studied in the temperature range from 0.95 to 1.2K. These mobilities range from slightly more than one to six times the mobility of the normal electron bubble state. The new carriers are found to be insensitive to impurities in the liquid, magnetic fields up to 1.2 kG, and to be stable for tens of milliseconds. Speculations on possible structures for the new negative carriers are given. Cross sections for ion–roton scattering are treated theoretically, using the unusual kinematic properties of the roton. It is found that the momentum transfer cross sections are far from geometrical, and strongly dependent on roton momentum. (Diss. Abstr. Int., B)

34799 SUPERCONDUCTING ENERGY GAP MEASURED BY TUNNELING INTO QUENCH-CONDENSED GERMANIUM–GOLD. Granqvist, C. G.; Claeson, T. (Chalmers Univ. of Tech., Goteborg). Phys. Lett.; 39A: No. 4, 271-2(22 May 1972).

$Ge_{0.5}Au_{0.5}$ films, quenched on a substrate below 2K are superconducting with $T_c = 3.10 \pm 0.12$ K, and $2\Delta(0)/k_BT_c = 3.75 \pm 0.1$. No phonon structure is visible in the second derivative of the tunnel current. (auth)

34800 PATH-DEPENDENT MAGNETIC STRUCTURES IN THE INTERMEDIATE STATE OF BULK LEAD. Kirchner, H.; Kiendl, A. (Siemens AG, Munich). Phys. Lett.; 39A: No. 4, 293-5(22 May 1972).

The magnetic structures of the intermediate state in bulk polycrystalline lead disks and cylinders established in raising the magnetic field from H = 0 exhibit marked differences compared with the structures observed at the same reduced field in lowering H from above $H = H_c$. The limiting field h_i defining the onset of irreversible flux penetration agrees well with the extrapolated part of the numerically computed curve given by Olafson. (auth)

34801 CRITICAL FLUCTUATIONS IN ZERO-DIMENSIONAL SUPERCONDUCTORS. Simanek, E. (Univ. of California, Riverside). Phys. Lett.; 39A: No. 4, 297-8(22 May 1972).

Time-dependent fluctuations of the order parameter in zero-dimensional superconductors are studied in the critical fluctuation region using the Langevin equation approach. (auth)

34802 FLUX LINE LATTICE IN AN INTRINSIC TYPE-II SUPERCONDUCTOR (VANADIUM). Lischke, B.; Rodewald, W. (Technical Univ., Berlin). Phys. Lett.; 39A: No. 4, 321-2(22 May 1972).

The flux line lattice in superconducting vanadium was observed directly. The lattice shows a slight deviation from the expected triangular symmetry, possibly caused by the anisotropic field distribution in the core of the flux lines. (auth)

34803 EVIDENCE FOR THE CONTROL OF THE CRITICAL CURRENT DENSITY OF Nb-25 PERCENT Zr SUPERCONDUCTING WIRES BY THE DISLOCATION SUBSTRUCTURE. Milne, I. (Central Electricity Research Labs., Leatherhead, Eng.). J. Mater. Sci.; 7: No. 4, 413-21(Apr 1972).

Transmission electron microscopy of longitudinal sections of 250-μm-diameter Nb−25% Zr wire revealed that annealing treatments that maximise J_c can cause polygonisation of the as-drawn dislocation substructure, precipitation of α-Zr, precipitation of β-Zr, or recrystallisation of β-Nb. It is argued that the polygonised structure is the one that is most effective in controlling J_c. T_c data provided some very useful information for assessing the constitutional state of the material. (auth)

34804 QUESTION OF A MODEL HAMILTONIAN IN THE THEORY OF SUPERCONDUCTIVITY. Bogolyubov, N. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Probl. Fiz. Elem. Chastits At. Yadr; 1: No. 2, 301-64(1971). (In Russian).

A system of fermions with an attractive force that can be described by a model Hamiltonian of the theory of superconductivity with a factorizing kernel is examined. The asymptotically precise (when $V \to \infty$) evaluations for the minimal eigenvalue of the Hamiltonian, the correlation functions, and the Green function are found. (TSS) (JPRS)

Equipment and Devices

Refer also to abstracts 34019, 34764, and 35247.

34805 BROADBAND SUPERCONDUCTING QUANTUM MAGNETOMETER. Kamper, R. A.; Simmonds, M. B. (National Bureau of Standards, Boulder, Colo.). Appl. Phys. Lett.; 20: No. 8, 270-2(15 Apr 1972).

The design, operation, and performance of a superconducting quantum interference device (SQUID), which operates at a frequency of 9 GHz, are described. It is sensitive to variations of magnetic field in a frequency band from 0 to 1 GHz. (auth)

34806 CONDUCTOR ARRANGEMENT COMPRISING ONE OR MORE CONDUCTORS FOR SUPERCONDUCTIVE CABLES. Ziemek, Gerhard; Eilhardt, Bernd (to Kabel- und Metallwerke Gutehoffnungshuette Aktiengesellschaft). British Patent 1,272,352. 26 Apr 1972. Priority date 7 Aug 1969, Germany.

A cable containing a plurality of coaxial tubes and having one or more superconducting conductors is described. An elongated tubular carrier is situated within the innermost tube. The superconducting conductors are attached to the inner wall of the tubular carrier. The conductors are attached to the inner wall of the tubular carrier as to exhibit a helical configuration. (M.H.R.)

34807 SUPERCONDUCTING CONDUCTOR. (to Compagnie Generale d'Electricite). British Patent 1,271,913. 26 Apr 1972. Priority date 25 Feb 1969, France.

The conductor described consists of an elongate metal conductor element having embedded along its entire length at least one wire or strip of superconducting material. A duct for cooling fluid extends parallel to the conductor element. The external surface of the duct has a longitudinal portion soldered to a corresponding portion on the conductor element. (M.H.R.)

34808 ULTRA-HIGH-VACUUM CRYOSTAT WITH AN INDEPENDENT PUMP. Kanter, B. Z. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 904-6(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 211-13(May-Jun 1971).

A portable all-metal demountable cryostat for investigating the surface properties of semiconductors in the temperature range from 300 to 77°K is described. The preliminary evacuation and degassing of the cryostat are carried out at a fixed pumping station from atmospheric pressure to a high vacuum by means of adsorption pumps. During the last stage of degassing and during the operating process the cryostat is evacuated down to $(1 \text{ to } 5) \times 10^{-9}$ torr by a magnetic electric-discharge pump. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 34760, 34852, 34930, 34963, 35016, 35193, and 35646.

34809 (AD–734872) MATHEMATICAL SOLUTIONS OF THE ONE-DIMENSIONAL NEUTRON TRANSPORT EQUATION. Davis, Larry Thomas (Naval Postgraduate School, Monterey, Calif.). Jun 1971. 92p. NTIS.

Thesis.

Considering the case of one speed, steady-state, isotropic scattering in homogeneous media with plane symmetry, this thesis developes the solution of the one-dimensional neutron transport equation by three separate techniques. The method of K. M. Case which makes use of the theory of generalized functions in forming a semi-classical eigenfunction expansion with both a continuous spectrum and a finite discrete spectrum is developed. Converting the neutron transport equation to an integral equation and then to a singular integral equation, a solution is found in a method due to T. W. Mullikin which has very useful convergence properties. Applying the method due to N. Weiner and E. Hopf to the integral equation form of the neutron transport equation, a solution is developed which depends heavily on complex variable theory. (auth) (NTIS)

34810 (AI-AEC–13018) SCORE-III-A: AN INTERACTIVE DISPLAY SYSTEM FOR EVALUATION OF MULTILEVEL RESONANCE PARAMETERS IN THE ADLER FORMAT. Rose, P. F. (Atomics International, Canoga Park, Calif.). 15 Mar 1972. Contract AT(04-3)-824. 35p. Dep. NTIS.

A study of techniques for using interactive computer graphics as an aid to neutron cross-section evaluation has been underway for some time. The result of this study is a computing system called SCORE. This document describes an experimental version of SCORE, detailing its use and explaining its capabilities. This version of SCORE, called SCORE-III-A, has been developed to provide a semi-automated procedure to fit experimental data with multilevel resonance parameters in the Adler–Adler formalism. (auth)

34811 (BNL–16700) PROGRAM SCOPE. Cullen, D. E. (Brookhaven National Lab., Upton, N. Y.). Apr 1972. 125p. Dep. NTIS.

This program is designed to allow File 3 ENDF/B data to be retrieved, plotted, changed, and/or compared with experimental data and/or data in the existing ENDF/B Version III Library in a time-sharing environment. An altered ENDF/B data tape may be optionally obtained as output. The program is written entirely in FORTRAN IV and specifically designed for implementation on the NNCSC PDP-10. The program listing is included. (R.W.R.)

34812 (BNWL–1634) GRANIT: A CODE FOR CALCULATING POSITION DEPENDENT THERMAL NEUTRON SPECTRA IN DOUBLY HETEROGENEOUS SYSTEMS BY THE INTEGRAL TRANSPORT METHOD. Bennett, C. L. (Battelle Pacific Northwest Labs., Richland, Wash.). Dec 1971. Contract AT(45-1)-1830. 81p. Dep. NTIS.

The position-dependent thermal neutron spectrum in doubly heterogeneous systems is calculated over the energy range 0 to 0.683 eV by the integral transport method with 30 speed points and a maximum of 30 space points. Dilute granular composite material regions are allowed. Both diluent and particle spectra are computed as a function of the radial position of the granular material in the cylindrical system. The computed spectrum is used to determine various one-thermal-group cross sections and reaction rates in the system for as many as five independent thermal energy ranges. Typical running times for 30 speed and space points are about 30 to 45 s per case on the UNIVAC 1108. The program is in FORTRAN. (1 figure, 1 table) (R.W.R.)

34813 (INR-P–1330) BOX EXPLICIT METHOD IN NEUTRON TRANSPORT THEORY. Arkuszewski, J.; Kulikowska, T.; Mika, J. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 43p. Dep. NTIS (U. S. Sales Only).

The rigorous approximation theory is applied to finite differencing the stationary one-velocity neutron transport equation in two-dimensional rectangular geometry. The existence of discontinuities of the first derivatives of the exact solution is exhibited and consequently taken into account in analyzing the approximation. The proposed Box Explicit Method (BEM) scheme is checked theoretically and numerically against the S_N diamond scheme. The BEM scheme shows a considerable advantage over the diamond one. (auth)

34814 (ORNL-TM–3791) CODE GASUMOS: DESCRIPTION AND USE. Wilson, J. V.; Tobias, M. L. (Oak Ridge National Lab., Tenn.). 5 May 1972. 7p. Dep. NTIS.

This memorandum describes the use of the code GASUMOS, a merger of codes GTP and SUMMIT which calculate neutron scattering kernels for a free gas and for a crystal, respectively. GASUMOS makes it possible to produce a kernel generated in part by each code in a single operation. (auth)

34815 (UCRL–51144(Rev.1)) LIVERMORE PULSED SPHERE PROGRAM: PROGRAM SUMMARY THROUGH JULY 1971. Wong, C.; Anderson, J. D.; Brown, P.; Hansen, L. F.; Kammerdiener, J. L.; Logan, C.; Pohl, B. (California Univ., Livermore. Lawrence Livermore Lab.). 10 Feb 1972. Contract W-7405-eng-48. 322p. Dep. NTIS.

Neutron emission spectra for spherical targets bombarded with a centered, nominal 14-MeV neutron source have been measured for many elements and compounds. These measurements have provided checks on the neutron transport codes and the input neutron cross section information. This report describes in detail the experimental technique employed and presents the spectra measured through July 1971. (auth)

34816 (UJV–2714-R) SOME SPECIAL CASES OF BOLTZMANN EQUATION IN THREE-DIMENSIONAL GEOMETRY. Kyncl, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1971. 14p. Dep. NTIS (U. S. Sales Only).

The procedure of solving the time-independent Boltzmann equation in three-dimensional geometry is presented. The particular solutions are found, and then it is proved they form a complete set. An an example the case of the homogeneous infinite medium with a point source is considered in detail. (auth)

34817 TIME-DEPENDENT RECTILINEAR TRANSPORT EQUATION. Montagnini, Bruno; Pierpaoli, Valeria (Politecnico, Milan). Transp. Theory Statist. Phys.; 1: No. 1, 59-75 (Jan 1971).

The rectilinear or rod model of neutron transport consists of a segment which is assumed to be capable of transporting particles. Such particles (neutrons) can move only to the right or to the left on the segment at a constant speed, and suffer scattering, capture and fission. It is shown that the time-eigenvalue spectrum of this model is made of a finite, non-void set of real eigenvalues, plus infinitely many complex eigenvalues, distributed in pairs of complex conjugates. A simple asymptotic formula for the high-order complex eigenvalues has been obtained. As an application, the following initial value probem was considered: find the outgoing density of neutrons, at one end of the rod, at any time after the injection of a neutron pulse at the same end. A complete series expansion of the outgoing density has been given. The successive time-derivatives of this expansion show certain characteristic discontinuities which are due to the motion, from one end of the rod to the other, of discontinuities (wave fronts) of the time-dependent neutron population. This suggests that the imaginary parts of the complex eigenvalues have just the task of representing the oscillatory motion of these wave fronts. (auth)

34818 PRODUCTION OF MONOENERGETIC NEUTRON BEAMS IN THE eV TO keV RANGE BY MEANS OF RESONANCE SCATTERERS IN THE TANGETIAL BEAM TUBE OF THE FRM. Dilg, W.; Vonach, H. (Technische Univ., Munich). Nucl. Instrum. Methods; 100: No. 1, 83-91(1972). (In German).

A method is described to produce beams of monoenergetic neutrons by means of resonance scatterers, placed in the tangential beam tube of a reactor. The method has been studied both experimentally, in measurements with some resonance sources at the Munich 4 MW Swimming Pool Reactor FRM, and theoretically, by estimating the important beam properties from the resonance parameters of the scatterers. In the measurements, sources of W, Co and NaF were used, yielding 19 eV, 130 eV and 2.8 keV neutron beams, with an estimated energy width $\Delta E/E$ of about 3%, 5% and 18%. The intensities of the well collimated beams were 2×10^4, 3×10^4 and 1×10^5 res.-neutrons/sec × 4 cm^2. The background of nonresonant neutrons in the spectra was studied by means of "self-transmission" and boron-transmission measurements in various experimental arrangements, involving the application of resonance detectors and the resonance filter difference technique. In the last section simple theoretical estimates for the beam properties: intensity, energy width, and background are given, which allow a more general discussion of the method and its range of application. The calculations are applied to a number of isotopes, which are suited as resonance scattering sources for the energy range 8 eV to 8 keV. (auth)

34819 THERMAL NEUTRON FOCUSING BY REFLECTIVE DISPERSION. Bandopadhyay, Pranab K. Kingston, R. I.; Univ. of Rhode Island (1971). 120p. University Microfilms Order No. 72-9787.

Thesis.

The problem of thermal neutron focusing by reflective dispersion is investigated. Neutrons which have made a large number of collisions with atoms of the moderator in a reactor at temperature T will tend to come into thermal equilibrium at that temperature and, therefore, are called thermal neutrons. Before being allowed to escape from the reactor these neutrons have a distribution of velocities which follows a Maxwellian curve appropriate to the temperature T. The equivalent wavelength, λ, of a thermal neutron is given by $\lambda = h/\sqrt{3mkT}$ where h is Plank's constant, k is Boltzman's constant and m is the mass of the neutron. By inserting a collimator into the face of the reactor a beam of thermal neutrons can be extracted. These neutrons, however, can go through total internal reflection on the surface of the collimator walls. This reflection depends on the energy of the neutrons and the material of the collimator chosen. It follows that thermal neutrons can be focused by reflection from the collimator surfaces. Hence, the study of the spatial and wavelength distributions of neutrons in a collimated beam from reflecting collimators is fundamental to any application of such focused beams. Neutron collimation through uniform rectangular tubes, rectangular tapered tubes and rectangular diverging tubes has been studied analytically to derive general expressions for the intensity and energy distributions of neutrons emerging from such collimators. Evaluation of these expressions, which is very difficult without making approximations, has been accomplished by Monte-Carlo simulation. The energy and spatial distributions of both the directly transmitted and reflected neutrons at several arbitrary locations in front of the collimators have been calculated. The results illustrate the generality of the procedure. Relevance of this technique to various experiments, e.g., capture experiments, neutron radiography and extraction of cold neutron beams, is discussed. An experimental study to confirm the gain in intensity of the neutron beam due to reflection on collimator walls is described. The analytical calculations and the simulation techniques are applied to different collimator geometries. Energy distribution, focusing of the beam and gain in intensity are dealt with in detail. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 33410 and 34022.

34820 K-HARMONICS METHOD IN A FEW NUCLEON PROBLEM. Efros, V. D. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 15: No. 2, 226-41(Feb 1972). (In Russian).

A method for the construction of a K-harmonic "physical" basis which takes into account the specifics of the few-particle nuclear problem as much as possible is given. The lowest approximation of this method—"potential harmonics"—is constructed explicitly. The formulas to calculate the matrix elements in a closed form are obtained in the "potential harmonics" approximation. The question of the p-wave weight and of the role of the LS and $(LS)^2$ forces in ^3H and ^4He is elucidated. (auth)

34821 ELASTIC ELECTRON SCATTERING WITH SHORT RANGE CORRELATIONS IN ^4He AND ^{16}O. Fink, M.; Hebach, H.; Schlitter, J.; Kuemmel, H. (Ruhr-Univ., Bochum, Ger.). Phys. Lett.; 39B: No. 2, 147-50(17 Apr 1972).

The form factors of ^4He and ^{16}O were calculated in the oscillator model including short-range correlations and corrections due to the nonself-consistency of the single-particle model. Various nucleon–nucleon potentials were used. With realistic potentials and the center-of-mass correction it is not possible to fit the experimental data. (auth)

34822 SCATTERING OF POLARIZED NEUTRONS BY ^3He AT 21.9 MeV. Busse, W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin); Efken, B.; Hilscher, D.; Morgenstern, H.; Scheer, J. A. Nucl. Phys.; A187: No. 1, 21-4(1972).

The asymmetries from $^3He(\vec{n}, n)^3He$ elastic scattering have been measured for 18 angles between 90 and 175° in the c.m. system at a neutron energy at 21.9 MeV in the lab system. The results are compared with the polarization of $^3H(\vec{n}, n)^3H$ and published phase shifts. A T = 0 contribution might be present at 37 MeV excitation energy in ^4He. (auth)

34823 CALCULATION OF THE RELATIVISTIC CHARGE FORM FACTOR OF THE DEUTERON DIRECTLY FROM EXPERIMENTAL n–p PHASE SHIFTS. Kukulin, V. I. (Moscow State Univ.); Troitskii, V. E.; Shirokov, Yu. M.; Trubnikov, S. V. Phys. Lett.; 39B: No. 3, 319-22(1 May 1972).

A new relativistic integral representation in terms of experimental n–p phase shifts alone for the charge form factor of the deuteron $G_C^d(q^2)$ is used. The results of the numerical calculation of $|G_C^d(q^2)|$ are presented for the s-wave deuteron in the interval of the four-momentum transfers squared $0 \le q^2 \le 30\ \mathrm{fm}^{-2}$. The change of sign in the experimental $^3S_1$-phase shifts leads to a dip and a prominent secondary maximum in $|G_C^d(q^2)|$. The calculated value of the deuteron charge root-mean-square radius RMSR is equal to the experimental one. (auth)

34824 NEUTRON PRODUCTION IN THE 120 MeV ALPHA PARTICLE BOMBARDMENT OF DEUTERIUM. Chamberlin, Edwin Phillip. College Station, Tex.; Texas A and M Univ. (1971). 111p. University Microfilms Order No. 72-13,209.

Thesis.

The neutron energy spectra from the α + d reaction at 120 MeV have been measured at eight angles. Time of flight and pulse height in an NE 218 liquid scintillator were recorded for each event. The resulting spectra were compared with quasi-elastic kinematic predictions. The location of high energy peaks in the 15, 18, and 21° spectra is slightly below that predicted by a "spectator proton" model. The pulse height response of the NE 218 scintillator to protons, deuterons, tritons, ^3He ions, and ^4He ions is also reported. (Diss. Abstr. Int., B)

34825 ATOMIC MASS MEASUREMENTS AT OSAKA UNIVERSITY. Ogata, K. (Osaka Univ.). J. Mass Spectrom. Ion Phys.; 8: No. 4, 365-78(Apr 1972).

The masses of H, D, ^{35}Cl and ^{37}Cl have been measured using the peak-matching technique with a double-focusing mass spectroscope operating with a mass resolution of $4-5 \times 10^5$. The accuracy of these measurements is estimated to be in the range, 1 part or slightly less in 10^8. Agreement with other measurements for H is good and for D not so good. The scattering of values for the chlorine isotopes is rather large. It appears that the investigation of systematic errors is still one of the most important things to do in the field of precise atomic mass measurements. (auth)

34826 SEARCH FOR STRUCTURE IN ^3He. Skopik, D. M.; Shin, Y. M. (Saskatchewan Accelerator Lab., Saskatoon). Can. J. Phys.; 50: No. 4, 392-4(15 Feb 1972).

The results of measurements on the $^3He(e,e'd)^1H$ reaction are presented. No evidence for structure in ^3He has been observed over the energy region 16 to 27 MeV. (auth)

34827 ELECTROMAGNETIC STRUCTURE OF THE ^3He NUCLEUS. Whitney, Randy Roy. Stanford, Calif.; Stanford Univ. (1971). 79p. University Microfilms Order No. 72-11,688.

Thesis.

The electromagnetic structure of the ^3He nucleus has been investigated by means of high-energy electron scattering. A separation of the charge and magnetic form factors has been accomplished. The charge form-factor data extend to $q^2 = 20\ \mathrm{fm}^{-2}$ and exhibit a diffraction minimum at $q^2 = 11.6\ \mathrm{fm}^{-2}$; the magnetic scattering is measured to $q^2 = 12.5\ \mathrm{fm}^{-2}$. The results are discussed in terms of theoretical calculations for the charge and magnetic distributions of the nucleus. (Diss. Abstr. Int., B)

34828 INVESTIGATION OF PROTON–PROTON QUASIFREE SCATTERING IN THE REACTION $^2H(p,2p)n$. McIntyre, J. A.; Beatty, P. H.; Bronson, J. D.; (and others) (Texas A and M Univ., College Station). Phys. Rev., C; 5: No. 5, 1796-9(May 1972).

An experimental test was made of the validity of the idea that the quasi-free scattering of a proton by the moving proton in the deuteron can be described as free proton–proton scattering modified only by an effective momentum distribution of the proton in the deuteron. The measurement confirmed the dependence on the proton momentum and also yielded the effective momentum distribution producing the scattering. (2 figures) (auth)

34829 MODIFIED PHASE-SHIFT ANALYSIS FOR p–^3He ELASTIC SCATTERING. Bolsterli, M.; Hale, G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 28: No. 19, 1285-7 (8 May 1972).

The phase-shift analysis of p–^3He elastic scattering is modified by using peripheral values for the phase shifts for l values corresponding to impact parameters greater than the nuclear radius. A marked improvement in the weighted variance is observed. A value of about 2.2 is obtained for the normalization of the tail of the ^3He wave function. (auth)

34830 POSSIBLE TESTS ON THE VERIFICATION OF AND DEPARTURE FROM $^1S_0 \to {}^3S_1$ RADIATIVE TRANSITION IN THER-

MAL n−p CAPTURE. Malik, S. S. (Univ. of Rhode Island, Kingston). Phys. Rev., C; 5: No. 5, 1807-10(May 1972).

Tests are suggested to verify the hypothesis that thermal n−p capture proceeds via the transition $^1S_0 \rightarrow {}^3S_1$ and that approximately 10% of the observed capture cross section is due to interaction effects. It is shown that measurements of the "γ polarization effect" using polarized neutrons and protons are capable of testing the predictions of the hypothesis to within 1%. (1 figure) (auth)

34831 MEASUREMENTS OF $^3H(d,\vec{n})^4He$ NEUTRON POLARIZATIONS FOR E_d = 1.0 to 5.0 MeV. Smith, J. R.; Thornton, S. T. (Univ. of Virginia, Charlottesville). Nucl. Phys.; A187: No. 2, 433-45(1972).

Neutron time-of-flight techniques and a liquid-helium polarized-neutron and analyzer were used to measure seven neutron polarization angular distributions for the $^3H(d,\vec{n})^4He$ reaction at deuteron energies from 1.0 to 5.0 MeV. Using Legendre polynomial expansions of $\sigma(\theta)$ and $P(\theta)\sigma(\theta)$, values of $P(\theta)$ and $P^2(\theta)\sigma(\theta)$ were calculated, and a contour map of $P(\theta)$ was produced for the energy range 1.0 to 5.0 MeV. Various techniques used to measure the $^3H(d,\vec{n})^4He$ polarizations are discussed, and previous and present results are compared. (auth)

34832 ANALYZING POWER OF THE $^3He(d,p)^4He$ REACTION FOR TARGET POLARIZATION BETWEEN 300 keV AND 2.5 MeV. **Rohrer, U.; Huber, P.; Leemann, Ch.; Meiner, H.; Seiler F. (Univ., Basel). Helv. Phys. Acta; 44: No. 7, 845-65(31 Dec 1971). (In German).**

The analyzing power of the $^3\overrightarrow{He}(d,p)^4He$-reaction for polarized target and unpolarized beam has been measured at 7 energies between 300 keV and 2.5 MeV and at angles between 30 and 150 degrees. The angular distributions show that a small part of the reaction proceeds via incoming p- and d-wave channels. In particular, d-wave contributions are considerably enhanced at 430 keV, the energy of the $\frac{3}{2}^+$-resonance. The incoming p-waves apparently proceed through a direct reaction mechanism, while the d-wave contributions are mainly produced by one d-wave matrix element, otherwise identical to the resonant s-wave matrix element. An optical method, capable of measuring the target polarization continuously during nuclear physics experiments, is also described. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 33410, 34821, 34913, 34919, 34966, and 34996.

34833 (RLO-1388-169) HEAVY ION EMISSION FROM LIGHT NUCLEI. Rudy, C.; Vandenbosch, R.; Russo, P.; Braithwaite, W. J. (Washington Univ., Seattle). [1971]. 36p. Dep. NTIS.

Reactions involving the emission of heavy ions leading to low-lying states of the residual nucleus have been studied using 42 MeV alpha particles incident on light target nuclei. The heavy ions resulting from these reactions were identified by mass number using the time of flight technique. With this method products with a mass number as high as A = 14 could generally be separated from neighboring isobars. Reactions leading to different particle masses from a particular target were studied simultaneously. Angular distributions and total cross sections were obtained for the reactions $^{12}C(^4He,^6Li)^{10}B$, $^{12}C(^4He,^7Be)^9Be$, $^{16}O(^4He,^6Li)^{14}N$, $^{16}O(^4He,^7Li)^{13}N$, $^{16}O(^4He,^7Be)^{13}C$ and $^{16}O(^4He,^9Be)^{11}C$. A comparison of the experimental angular distributions and cross sections with statistical model calculations was carried out. It is shown that as the mass of the emitted heavy ion increases for a particular reaction, the fractional contribution of compound nuclear processes increases. Considerable compound nuclear contributions to all the reactions studied are indicated. Comparison of the calculated and experimental results for the $^{16}O(^4He,^7Be)$ and $^{16}O(^4He,^7Li)$ reactions with those for the reaction $^{16}O(^4He,^8Be)^{12}C$ indicate that there is no enhancement of the latter reaction due to alpha clustering. Evidence is given for the conservation of isotopic spin in complex reactions proceeding through a short-lived compound nucleus. The possible astrophysical significance of low energy alpha particle induced reaction in the nucleosynthesis of Li, Be, and B is discussed. (auth)

34834 INFLUENCE OF THE FRACTIONAL PARENTAGE STRUCTURE OF THE GROUND STATE ON THE LIGHT NUCLEI PHOTODISINTEGRATION. Goncharova, N. G. (Moscow State Univ.). Yadern. Fiz.; 15: No. 2, 242-7(Feb 1972). (In Russian).

Dipole excitations of the nuclei ^{14}N and ^{15}N are calculated on a basis of the wave functions of the shell model with intermediate coupling. The partial probabilities of transitions to the final nuclear levels and nuclear spectra peculiarities due to excited-state decays are considered. (auth)

34835 ^3He ELASTIC, INELASTIC, AND CHARGE-EXCHANGE SCATTERING FROM ^6Li AT 24.6 AND 27.0 MeV. Givens, Roger Wayne. Urbana, Ill.; Univ. of Illinois (1971). 109p. University Microfilms Order No. 72-12,175.

Thesis.

A target consisting of ^6Li evaporated onto a carbon foil backing was bombarded with the ^3He beam from the University of Illinois cyclotron. Solid state detectors in $\Delta E - E'$ telescopes were used to obtain energy spectra of the scattered ^3He and of tritons from the charge exchange reaction. Differential cross sections were determined for elastic scattering, inelastic scattering to the first two excited states of ^6Li, and the $(^3He,t)$ charge exchange reaction to the ground state of ^6Be, at energies of 24.6 and 27.0 MeV over angular ranges of approximately 20 to 115° or more (cm). In order to observe the transition to the 3.56 MeV second excited state of ^6Li, it was necessary to require a coincidence with the recoil nucleus at most of these angles. The cross sections for this transition are compared to those for the charge-exchange reaction. (Diss. Abstr. Int., B)

34836 STUDY OF ^{17}O VIA ^3He BOMBARDMENT OF ^{14}C. **Keyser, R. M.; Blue, R. A.; Weller, H. R. (Univ. of Florida, Gainesville). Nucl. Phys.; A186: No. 3, 528-44(1972).**

Angular distributions and excitation functions have been measured for the $^{14}C(\tau,\tau)^{14}C$ reaction and for the $^{14}C(\tau,\alpha)^{13}C$ reactions leading to the ground and first three excited states of ^{13}C for bombarding energies of from 2 to 7 MeV. In addition, excitation functions were measured for the outgoing deuteron channel to the ground state of ^{15}N, and the outgoing proton channels leading to the ground and first three excited states of ^{16}N for bombarding energies of 3 to 5 MeV. Three new levels in ^{17}O are established from these data. These levels occur at 21.7 ± 0.1, 22.1 ± 0.1 and 23.0 ± 0.1 MeV in ^{17}O and, on the basis of a two-level analysis of the α-channel data and an optical-model-plus resonance (OMPR) analysis of the elastic data, are assigned J^π values of $\frac{5}{2}^+$, $\frac{7}{2}^-$ and $\frac{1}{2}^+$ respectively. Recently reported measurements of the $^{14}C(\tau,\gamma_0)^{17}O$ cross section are in agreement with these results. These levels are compared with the corresponding states presently known in ^{17}F at similar energies. (auth)

34837 REACTION $^{15}N(d,p)^{16}N$(UNBOUND) AND THE OFF-ENERGY-SHELL n–^{15}N TOTAL CROSS SECTION. Lipperheide, R. (Univ., Munich); Moehring, K. Phys. Lett.; 39B: No. 3, 323-6(1 May 1972).

The recently observed near parallelism between the proton spectra from the reaction $^{15}N(d,p)^{16}N$(unbound) and the n-^{15}N total cross section is studied. The remaining discrepancies are explained qualitatively in terms of off-energy-shell and distorted-wave effects. (auth)

34838 INVESTIGATION OF CHARGED SECONDARIES EMITTED UPON ABSORPTION OF STOPPED π-MESONS BY CARBON. Larson, D. A.; Carruth, R. T.; French, J. D. (Auburn Univ., Ala). Nucl. Instrum. Methods; 100: No. 2, 325-7(1972).

One thousand interactions of stopped negative pions with carbon nuclei have been investigated using Ilford K.2 emulsion loaded with diamond chips. The results are compared with an evaporation calculation by Guthrie, Alsmiller and Bertini and estimates by Fowler and Mays. (auth)

34839 $\frac{5}{2}^-$ RESONANCE AT 850 keV IN $^{15}N(\alpha,\gamma)^{19}F$. Rogers, D. W. O.; Aitken, J. H.; Litherland, A. E. (Univ. of Toronto). Can. J. Phys.; 50: No. 3, 268-77(1 Feb 1972).

A weak resonance at 850 keV in $^{15}N(\alpha,\gamma)^{19}F$ corresponding to a level at 4681 ± 1 keV in ^{19}F was found. Angular distributions and Doppler shifts were measured for the primary decays to the $\frac{5}{2}^-$ level at 1.35 MeV (63%), $\frac{3}{2}^-$ level at 1.46 MeV (31%), and the $\frac{5}{2}^+$ level at 197 keV (6%). A spin of $\frac{5}{2}$ was assigned to the resonance level and negative parity is shown to be very likely. The lifetime of the resonance was measured by the Doppler shift attenuation method to be $\tau = (15.4 \pm 3.0) \times 10^{-15}$ s or $\Gamma = 42.8 \pm 8.5$ meV. The measured value of $\omega\gamma$ was 6.0 ± 1.0 meV. These measurements together with previous information on Γ_γ/Γ imply the observed M1 transition strengths are a factor of 20 weaker than predicted for the $\frac{5}{2}$ member of the $K = \frac{3}{2}^-$ band in ^{19}F which has previously been associated with this level. (auth)

34840 DETERMINATION OF THE DEFORMATION OF ^{12}C USING INELASTIC SCATTERING OF POLARIZED PROTONS. de Swiniarski, Rene (Univ., Grenoble, France). Compt. Rend., Ser. B; 274: No. 7, 506-9(14 Feb 1972). (In French).

Coupled equations calculations were made, which led to the determination of the quadrupolar deformation of ^{12}C (defined by $\beta_2 = -0.72$) without sign ambiguity. (France)

34841 α-PARTICLE TRANSFER VIA THE (^{12}C,^{8}Be) REACTION: APPLICATION TO STUDIES OF ^{16}O AND ^{20}Ne. Wozniak, G. J.; Harney, H. L.; Wilcox, K. H.; Cerny, Joseph (Univ. of California, Berkeley). Phys. Rev. Lett.; 28: No. 19, 1278-81 (8 May 1972).

The reactions $^{12}C(^{12}C, ^{8}Be)^{16}O$ and $^{16}O(^{12}C, ^{8}Be)^{20}Ne$ were studied by utilizing particle-identification techniques to detect the two breakup α particles from ^{8}Be. The (^{12}C, ^{8}Be) reaction strongly populates the positive-parity four-particle—four-hole rotational band of ^{16}O based on its 6.05-MeV (0^+) state, and both the positive- and negative-parity rotational bands of ^{20}Ne based on its ground-state (0^+) and 5.80-MeV (1^-) state, respectively. (auth)

34842 RADIATIVE ELECTRON CAPTURE IN ^{7}Be. Persson, Boerje I.; Koonin, Steven I. (California Inst. of Tech., Pasadena). Phys. Rev., C; 5: No. 5, 1443-52(May 1972).

The continuous spectrum of photons accompanying the electron-capture transition from ^{7}Be to the first excited state in ^{7}Li was measured in coincidence with the nuclear γ rays from the deexcitation of this state. The end-point energy of the photon spectrum was determined to be 388 ± 8 keV, in good agreement with accepted mass differences. The probability of 1s + 2s radiative capture giving a photon energy greater than 50 keV per nuclear γ ray was determined to be $(10.3 \pm 0.6) \times 10^{-5}$. This result should be compared with the value 9.2×10^{-5} predicted by the theory of Martin and Glauber. At energies higher than 120 keV the shape of the spectrum agrees with the predictions of theory. At energies lower than 120 keV the intensity falls off faster than expected from the theory. Exchange and overlap corrections to the radiative-capture theory were calculated and shown to be too small to account for the observed discrepancy. (6 figures, 1 table) (auth)

34843 ANGULAR DISTRIBUTION OF GAMMA RAYS FROM THE REACTION $^{12}C(^{6}Li,d)^{16}O$. Carlson, R. R. (Univ. of Iowa, Iowa City). Phys. Rev., C; 5: No. 5, 1467-72(May 1972).

Angular distributions of the 6.92- and 7.12-MeV γ radiation from the reaction $^{12}C(^{6}Li,d)^{16}O$ were measured as functions of bombarding energy in order to obtain information about the reaction mechanism. Bombarding energies were at, and below, the Coulomb barrier for these low, negative-Q reactions. The tendency to proceed by a direct-reaction mechanism should be enhanced under these conditions. Results are compared with plane-wave calculations and are in reasonable agreement for the 6.92-MeV radiation but in strong disagreement for the 7.12-MeV radiation. (5 figures) (auth)

34844 SCATTERING OF NEUTRONS BY CARBON FROM 3 TO 7 MeV. Galati, W.; Brandenberger, J. D.; Weil, J. L. (Univ. of Kentucky, Lexington). Phys. Rev., C; 5: No. 5, 1508-29(May 1972).

Angular distributions of neutrons elastically scattered from natural carbon were measured at 32 neutron energies between 3 and 7 MeV with energy spreads ranging from 37 to 165 keV. The angular distributions of neutrons inelastically scattered from ^{12}C were also measured at the nine highest neutron energies. A phase-shift analysis of the elastic scattering cross sections yields the following spin and parity assignments for the excited states of $^{13}C(E_x,J)$: 8.3 MeV, $3/2^+$; 8.88 MeV, $1/2^-$; 9.50 MeV, $(1/2, 3/2)^-$; 9.90 MeV, $3/2^-$; 10.75 MeV, $7/2^-$; 11.00 MeV, $(1/2^+)$. Neutron polarizations calculated from the extracted phase shifts agree fairly well with most of the available polarization measurements. A polarization contour map is given showing that carbon may be useful as a polarization analyzer between 4.5 and 7 MeV. (19 figures, 12 tables) (auth)

34845 STUDY OF THE $^{11}B(\vec{d},n)^{12}C$ REACTION WITH POLARIZED DEUTERONS AT $\bar{E}_d$ = 900 keV. Rizvi, S. M.; Huber, P.; Seiler, F.; Striebel, H. R. (Univ., Basel). Helv. Phys. Acta; 44: No. 7, 803-14(31 Dec 1971).

The analyzing power of the $^{11}B(\vec{d},n)^{12}C$ reaction for the neutron group leaving the ^{12}C nucleus in the ground state has been measured at a mean deuteron energy of $\bar{E}_d$ = 900 keV. An analysis of the results shows that the major contribution to the reaction at this energy comes from a $5/2^-$ state of the compound nucleus ^{13}C with s-waves in the entrance channel. It is shown that this is possibly the 19.7-MeV level in ^{13}C. (auth)

34846 MEASUREMENT OF DIFFERENTIAL CROSS SECTIONS OF THE $^{14}N(n,\alpha)^{11}B$ AND $^{12}C(n,\alpha)^{9}Be$ REACTIONS BETWEEN 14.8 AND 18.8 MeV. Salathe, W.; Baumgartner, E.; Huber, P. (Univ., Basel). Helv. Phys. Acta; 44: No. 7, 815-29(31 Dec 1971). (In German).

The differential cross section of $^{14}N(n,\alpha_0)^{11}B$, $^{14}N(n,\alpha_1)^{11}B^*$ and $^{12}C(n,\alpha_0)^{9}Be$ has been measured at 30 neutron energies between 14.8 and 18.8 MeV with 60 keV energy spread at angles between 0 and 156 degrees. Indications are given that the reaction $^{14}N(n,\alpha_0)^{11}B$ proceeds partly by formation of a compound nucleus. (auth)

34847 TENSOR POLARIZATION OF ELASTICALLY SCATTERED DEUTERONS ON ^{12}C BETWEEN 1.6 AND 2.7 MeV. Meyer, H. O.; Huber, P.; Baumgartner, E. (Univ., Basel). Helv. Phys. Acta; 44: No. 7, 830-45(31 Dec 1971). (In German).

The spin tensor moments t_{20}, t_{21} and t_{22} of initially unpolarized deuterons elastically scattered from ^{12}C have been measured with the $^{3}H(d,p)^{4}He$ reaction as an analyzer of deuteron polarization. The three deuteron polarization parameters are presented as functions of incident deuteron energy between 1.6 and 2.7 MeV at 30°, 51°, 75° and 105° scattering lab angles. A phase-shift analysis of the differential cross-section and the polarization near the 2.50 MeV resonance confirmed the level parameters of the 12.41 MeV level in ^{14}N as assigned by McEllistrem et al. No reasonable set of parameters could be found to reproduce the data near the anomaly at 1.79 MeV. (auth)

34848 $^{14}N(\alpha,d)^{16}O$ AT 30 MeV. Lowe, J. (Univ. of Birmingham, Eng. Univ. of Minnesota, Minneapolis); Barnett, A. R. Contract AT(11-1)1265. Nucl. Phys.; A187: No. 2, 323-36(1972).

Data are presented for $^{14}N(\alpha,d)^{16}O$ at E_α = 29.98 MeV, to states of ^{16}O at 6.92, 7.12, 9.85, 10.35, 11.09, 11.52, 14.400, 14.815 and 16.214 MeV. Cross sections cover the range 10° to about 100° (lab). Excitation energies and widths are obtained for the following states: 11.094 ± 0.003 MeV, 14.400 ± 0.003 MeV ($\Gamma_{c.m.} \leq 30$ keV), 14.815 ± 0.002 MeV ($\Gamma_{c.m.} = 60 \pm 12$ keV) and 16.214 ± 0.015 MeV ($\Gamma_{c.m.} = 96 \pm 16$ keV). Comparison with other data establishes the following states in this energy region: 2p-2h states at 14.400 MeV (5^+), 14.815 MeV (6^+) and 16.214 MeV (4^+), and a collective, 4p-4h state at 16.304 MeV (6^+). The existence of two 6^+ states and of strong 2p-2h structure in this region is in agreement with recent extensive shell-model calculations. However, the spin sequence of the 2p-2h states, and the structure of the 4^+ state, do not seem to be consistent with these calculations. (auth)

34849 CALCULATIONS FOR QUASI-ELASTIC SCATTERING ^{12}C, ^{16}O, AND ^{40}Ca AT 460 MeV. Person, Lucy W.; Benioff, Paul (Argonne National Lab., Ill.). Nucl. Phys.; A187: No. 2, 401-25(1972).

Differential (p, 2p) reaction cross sections are calculated for various shells of ^{12}C, ^{16}O and ^{40}Ca at 460 MeV and are compared with experiment. The DWIA calculations are carried out in the momentum representation which requires the use of a distorted-wave function which is different from the one in wide use at high energies. The difference between the two approximations is appreciable but not large, and both agree fairly well with experiment. Comparison of the coplanar symmetric with the non-coplanar symmetric cross sections for the $2s_{1/2}$ shell of ^{40}Ca show an interesting effect. This is that the nodal structure of the radial wave function is strongly suppressed in the former type but not in the latter type. (auth)

34850 STUDY OF TRANSITION RATE RENORMALIZATION INDUCED BY 2p—2h GROUND-STATE ADMIXTURES. Walker, G. E. (Indiana Univ., Bloomington). Phys. Rev., C; 5: No. 5, 1540-52(May 1972).

The magnitude of nuclear transition matrix elements calculated in the particle—hole model often must be renormalized to give agreement with experiment. Admixtures of the 2p—2h type are introduced into the ground state (of "closed-shell nuclei"), and transitions to the usual configuration-mixed p—h states are considered. The resulting renormalized transition matrix elements are, for reasonable choices of the ground-state correlations, in better agreement with experiment. Because proper treatment of the excited states is also required for detailed comparison with experiment in the case of partial transitions, the total muon-capture rate is studied using the closure approximation. It is found that introduction of 2p—2h states into the ground state does not remove the theoretical—experimental discrepancy for the total capture rate in ^{16}O if the usual range of values for the "average" neutrino momentum is adopted. (2 figures) (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 33375, 34027, 34413, 34825, 34873, 34893, 35004, and 35042.

34851 (CEA-R-4279) INELASTIC SCATTERING OF 14-MeV NEUTRONS BY Mg, Al, Si, S, Ca, Sc, Fe, Ni, Cu, Au, Pb, AND Bi. Clayeux, Genevieve; Voignier, Jacques (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Mar 1972. 33p. (In French). Dep. NTIS (U. S. Sales Only).

The inelastic scattering cross sections of 14 MeV neutrons by Mg, Al, Si, S, Ca, Sc, Fe, Ni, Cu, Au, Pb and Bi have been studied using conventional time-of-flight techniques. The energy spectra of scattered neutrons were measured in the energy range 100 keV–7 MeV ($\theta = 90°$). The values obtained for the various differential cross sections are compared with previous results. (auth)

34852 (NP–19159) THEORETICAL AND NUMERICAL STUDY OF INELASTIC NEUTRON SCATTERING IN AN ANHARMONIC CRYSTAL. Bohlin, Leif (Umea Univ. (Sweden). Dept. of Theoretical Physics). 1971. 52p. (In Swedish). Dep. NTIS (U. S. Sales Only).

An introduction is given to the theory of coherent inelastic scattering of neutrons in an anharmonic crystal. Numerical calculations on neon, argon, krypton and xenon are presented. Differential scattering cross sections for one-phonon processes are calculated using Lennard–Jones (6,12)-potential and perturbation theory. (Sweden)

34853 (UCRL-Trans–10600) EMISSION OF CHARGED PARTICLES AFTER THE ABSORPTION OF SLOW NEUTRONS IN ^{22}Na. Ehehalt, R.; Morinaga, H.; Shida, Y. Translated for Univ. of California, Lawrence Livermore Lab., Livermore from Z. Naturforsch.; 26a: No. 3, 590-1(1971). 6p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 53696.

34854 HAUSER–FESHBACH METHOD FOR MANY-PARTICLE NUCLEAR REACTIONS. Savel'ev, A. E. Yadern. Fiz.; 15: No. 2, 272-7(Feb 1972). (In Russian).

The Hauser–Feshbach method, well-known in cross-section calculations, is generalized to the case of many-particle nuclear reactions. A possibility of correlations between particles produced in succession is discussed. An example of the numerical calculations of the sum of the (n,p) and (n,pn) cross sections is given. (auth)

34855 STATIC AND DYNAMIC QUADRUPOLE MOMENTS OF THE FIRST EXCITED STATES OF ^{20} ^{22}Ne. Olsen, D. K.; Phillips, W. R.; Barnett, A. R. (Univ. of Manchester, Eng.). Phys. Lett.; 39B: No. 2, 201-3(17 Apr 1972).

A projectile Coulomb excitation technique which is insensitive to many sources of systematic error was used to remeasure the static quadrupole moments of 2_1^+ states in ^{20,22}Ne. The results for Q, and for B(E2), remove present discrepancies with the rotational model. (auth)

34856 DEPENDENCE OF THE DOPPLER SHIFT LIFETIME METHOD ON SLOWING ENVIRONMENT. Broude, C.; Engelstein, P.; Popp, M.; Tandon, P. N. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Lett.; 39B: No. 2, 185-7(17 Apr 1972).

To check for systematic analysis errors in the Doppler shift attenuation method for nuclear lifetimes, a mean life in ^{22}Ne was measured in 39 different solid elemental slowing materials. A range of lifetimes of 1.9, strongly correlated with atomic number, was observed. (auth)

34857 INELASTIC ELECTRON SCATTERING FORM-FACTORS CALCULATED FROM SHELL-MODEL WAVE FUNCTIONS. Hammerstein, G. R.; Larson, Duane; Wildenthal, B. H. (Michigan State Univ., East Lansing). Phys. Lett.; 39B: No. 2, 176-8(17 Apr 1972).

Form-factors measured for (e,e') on ^{20}Ne, ^{24}Mg, ^{28}Si, and ^{32}S are well reproduced by calculations which use shell-model wave functions and scaling factors consistent with the usual effective-charge assumptions. (auth)

34858 DETERMINATION OF DEFORMATION PARAMETERS OF ^{20}Ne AND ^{22}Ne BY INELASTIC SCATTERING OF POLARIZED PROTONS. de Swiniarski, R. (Univ. of California, Berkeley); Bacher, A. D.; Resmini, F. F.; (and others). Phys. Rev. Lett.; 28: No. 17, 1139–42(24 Apr 1972).

Measurements of cross sections and analyzing powers were made for the inelastic scattering of 24.5-MeV polarized protons leading to the lowest 0^+, 2^+, and 4^+ states in ^{20}Ne and ^{22}Ne. The results for both ^{20}Ne and ^{22}Ne are best reproduced when the full Thomas form of the deformed, spin-dependent optical potential is employed in coupled-channels calculation. In contrast to ^{20}Ne, the results for ^{22}Ne indicate that only a small hexadecapole deformation is needed to reproduce both the cross sections and the analyzing powers for the ^{22}Ne ground-state rotational band. (auth)

34859 STUDY OF NEUTRON PICKUP BY THE N = 20 ISOTONES ^{40}Ca, ^{39}K, AND ^{37}Cl. Ronsin, G. (Institut de Physique Nucleaire, Orsay, France); Vergnes, M.; Rotbard, G.; Kalifa, J.; Linck, I. Nucl. Phys.; A187: No. 1, 96-122(1972). (In French).

Neutron pick-up in the N = 20 closed shell has been studied for the three isotones ^{40}Ca, ^{39}K and ^{37}Cl using the (^{3}He, α) reaction. The results have been analyzed with previously determined optical potentials and the spectroscopic factors compared to theoretical values calculated from several models. New levels have been observed in ^{38}K and ^{36}Cl. Spins, parities and isospins have been tentatively assigned to some of them. (auth)

34860 LIFETIME OF THE LOWEST 5^- STATE IN ^{38}Ar MEASURED BY RECOIL-DISTANCE AND DOPPLER-SHIFT TECHNIQUES. Lindskog, J.; Gordon, D. M.; Kavanagh, R. W. (California Inst. of Tech., Pasadena). Nucl. Phys.; A187: No. 1, 1-11(1972).

The lifetime of the lowest 5^- state in ^{38}Ar has been measured, using both the recoil-distance technique and the Doppler-shift-attenuation method with xenon gas as the slowing-down medium. Agreement between the two experimental values is obtained. The recoil-distance measurement, which is considered to be the more reliable, gave a mean-life of 226 ± 21 ps. (auth)

34861 TWO-HOLE STRENGTHS IN ^{38}K FROM THE ^{39}K (^{3}He, α)^{38}K REACTION. Fenton, J. A. (Rutgers–The State Univ., New Brunswick, N. J.); Kruse, T. H.; Williams, N.; (and others). Nucl. Phys.; A187: No. 1, 123-40(1972).

States in ^{38}K up to 7.13 MeV excitation have been studied using the 21 MeV ^{3}He^{++} beam of a tandem Van de Graaff and the ^{39}K (^{3}He, α) reaction. Charged particles were analyzed by a split-pole magnetic spectrograph equipped with a telescope arrangement of proportional counters for position and energy-loss measurement. Several levels (presumably T = 0) not previously seen in single-nucleon pick-up leading to A = 38 nuclei have been observed. Spectroscopic factors for $s_{1/2}$ and $d_{3/2}$ or $d_{5/2}$ pickup have been derived using DWBA calculations. Most of the shell-model $s_{1/2}$ and $d_{3/2}$ strength was observed. The admixtures of ($s_{1/2}^{-1}d_{3/2}^{-1}$) and $(d_{3/2})^{-2}$ configurations in states of known spin-parity were inferred from the spectroscopic factors. Results indicate large 2p–4h admixtures in some states, independent of the ambiguity between $d_{3/2}$ and $d_{5/2}$ pickup. The dominance of the l = 0 transition to the 3.42 MeV (2^+, 0) state clearly distinguishes among recent realistic shell-model calculations. Observed mixtures of l = 0 and l = 2 strengths disagree with predictions of appreciable $d_{5/2}$ strength below 5 MeV. (auth)

34862 WHAT CAN BE LEARNED FROM DE-EXCITATION EXPERIMENTS? Bely, Yu, I. (Moscow State Univ.); Yudin, N. P.; Majling, L.; Rizek, J. Phys. Lett.; 39B: No. 3, 335-6 (1 May 1972).

The influence of the γ-cascade on the population of low-lying levels of residual nuclei is discussed in connection with (γ,pγ') and (γ,nγ') reactions on the ^{32}S nucleus. (auth)

34863 BRANCHING RATIOS AND LIFETIMES IN ^{30}Si. Gallmann, A.; Haas, F.; Toulemonde, M. (Univ. Laval, Quebec. Laboratoire de Physique Nucleaire et d'Instrumentation, Strasbourg). Can. J. Phys.; 50: No. 3, 278-86(1 Feb 1972). (In French).

Gamma rays from the decay of ^{30}Si levels with excitation energies less than 6.0 MeV were studied by the ^{27}Al(α,pγ)^{30}Si reaction. The γ rays were detected in a Ge(Li) detector in coincidence with protons observed in an annular detector placed at 180°. Branching ratios and lifetimes were extracted. The lifetimes were measured by the Doppler-shift attenuation method. The electromagnetic matrix elements for some of the observed levels were compared with recent many-particle shell model and core-coupling calculations. (auth)

34864 NUCLEAR STRUCTURE OF ^{30}P AND ^{34}Cl IN A UNIFIED MODEL. Singh, B. P. (Queen's Univ., Kingston, Ont.); Castel, B.; Johnstone, I. P.; Stewart, K. W. C. Phys. Rev., C; 5: No. 5, 1613-22(May 1972).

The low-lying structure of the odd–odd nuclei ^{30}P and ^{34}Cl is studied in a modified version of the vibrational unified model in which anharmonic and quasi-particle effects are included. The results are compared with recent shell-model calculations and yield satisfactory agreement with recently observed level schemes and decay rates. (2 figures, 5 tables) (auth)

34865 LOWEST-LYING $J\pi = 1/2-$ LEVELS IN ^{21}Ne AND ^{23}Na. Pilt, Aadu A. (McMaster Univ., Hamilton, Ont.). Phys. Rev., C; 5: No. 5, 1786-8(May 1972).

The isospin-dependent particle–hole interaction of Bansal and French is shown to predict adequately the energies of the anomalously low-lying $J\pi = 1/2-$ states in ^{21}Ne and ^{23}Na. (1 table) (auth)

34866 INVESTIGATION OF THE ^{26}Mg(d,p)^{27}Mg REACTION BELOW 3 MeV. Lin, E. K. (Tsing Hua Univ., Taiwan); Wang,

W. N.; Yu, J. G.; Tung, W. C. Nuovo Cim.; 8A: No. 4, 801-11 (21 Apr 1972).

A study was made of the reaction $^{26}Mg(d, p)^{27}Mg$ in the deuteron energy range from 2.0 to 3.0 MeV. Angular distributions in the range of 30 to 140° at E_d = 2.1, 2.3, 2.5, 2.7, 2.8 and 3.0 MeV were measured. Excitation functions ranging from 2.0 to 3.0 MeV were obtained for the reactions leading to the ground and first excited states of ^{27}Mg. The direct stripping effect was found to give a considerable contribution to the P_0-transition, and its significance appears to increase gradually at bombarding energies from 2.1 to 3.0 MeV. The distorted-wave Born approximation (DWBA) was used to calculate the spectroscopic factor for the ground state. The measured angular distributions of higher proton transitions indicate that compound nucleus formation becomes more important relative to the stripping process. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 33375, 34849, 34851, 34852, 34859, 34884, 34885, 34893, 34913, and 34966.

34867 (INP–783) INELASTIC SCATTERING OF 12.8 MeV DEUTERONS FROM ^{39}K NUCLEI. Budzanowski, A.; Elbek, B.; Grotowski, K.; Kobos, A.; Strzalkowski, A.; Wiktor, S. (Institute of Nuclear Physics, Krakow (Poland)). Dec 1971. 37p. Dep. NTIS (U. S. Sales Only).

The cross sections for the elastic and inelastic scattering of 12.8 MeV deuterons by ^{39}K have been measured by means of a broad-range magnetic spectrograph. Angular distributions from 20 to 145° were obtained for deuterons inelastically scattered to the 2.53, 2.82, 3.02, 3.60, 3.88, 3.94, 4.08 + 4.09, 4.12, 4.51 and 5.17 MeV states in ^{39}K. These cross sections are analyzed with the DWBA theory and the angular momentum transfer and dynamical deformation parameters are determined. A discussion of the structure of the ^{39}K levels in terms of the excited core model is given. (auth)

34868 (INR–1368) ANALOG STATES IN THE ISOBARIC PAIRS ^{57}Fe–^{57}Co, ^{53}Cr–^{53}Mn, AND ^{46}Sc–^{46}Ti. Zych, Wlodzimierz (Institute of Nuclear Research, Warsaw (Poland)). 1971. 98p. (In Polish). Dep. NTIS (U. S. Sales Only).

Some problems concerning the investigation of analog resonances through elastic scattering of protons on intermediate nuclei are presented. The experimental conditions are discussed and the results of the measurement of the resonances in proton elastic scattering on ^{56}Fe, ^{52}Cr, ^{45}Sc are presented along with their classification into the analog pairs ^{57}Fe–^{57}Co, ^{53}Cr–^{53}Mn and ^{46}Sc–^{46}Ti. The factors influencing the excitation and investigation of analog resonances are discussed. The role of analog states in nuclear spectroscopy is considered. The results concerning the analog pair ^{46}Sc–^{46}Ti are presented for the first time. The experiments concerning the proton scattering on ^{45}Sc will be continued. (auth)

34869 INTERFERENCE OF THE TWO SPIN COMPONENTS OF THE CAPTURE STATE IN THE (n,γ) REACTION. Op Den Kamp, A. M. F. (FOM-RCN Nuclear Structure Group, Petten, Netherlands); Kopecky, J.; Stecher-Rasmussen, F.; Abrahams, K.; Endt, P. M. Phys. Lett.; 39B: No. 2, 204-6(17 Apr 1972).

Measurements of the circular γ-ray polarization for primary transitions in the $^{39}K(n,\gamma)^{40}K$ and $^{57}Fe(n,\gamma)^{58}Fe$ reactions induced by thermal neutrons give strong evidence for the interference of components in the capture state with different J values. (auth)

34870 $^{57}Fe(d,p)^{58}Fe$ REACTION AND THE STRUCTURE OF ^{58}Fe. Rapaport, J. (Ohio Univ., Athens); Trier, A.; Belote, T. A.; Dorenbusch, W. E. Contract AT(30-1)-2098. Nucl. Phys.; A187: No. 1, 25-37(1972).

The level structure of ^{58}Fe has been studied by the ^{57}Fe(d, p) reaction with 7.0-MeV incident deuterons, using the MIT multiple-angle spectrograph. Experimental angular distributions are compared with distorted-wave Born approximation calculations. Angular momentum values are determined for the observed transitions up to approximately 6.0 MeV excitation energy. Spectroscopic strengths are deduced from the data. The results are analyzed in terms of shell-model sum rules. (auth)

34871 GAMMA-RAY SPECTRA AND LEVEL STRUCTURE OF ^{55}Cr FROM THERMAL NEUTRON CAPTURE IN ^{54}Cr. White, D. H.; Howe, R. E. (Univ. of California, Livermore). Nucl. Phys.; A187: No. 1, 12-20(1972).

Gamma-ray measurements have been made of the $^{54}Cr(n,\gamma)^{55}Cr$ reaction at the Livermore reactor. Spectra were taken with Ge(Li) Compton-suppression and pair-coincidence spectrometers. A total of 83 observed γ-rays are attributed to capture in ^{54}Cr, of which 26 are assigned to specific transitions among 10 inferred levels in ^{55}Cr. The neutron binding energy is determined to be 6246.3 ± 0.4 keV. (auth)

34872 $^{46}Ti(d,\tau)^{45}Sc$ REACTION: EVIDENCE FOR $f_{7/2}$ SINGLE PROTON CONFIGURATIONS IN THE GROUND STATE OF ^{46}Ti. Mairle, G.; Wagner, G. J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys.; 251: No. 5, 404-15(1972).

The $^{46}Ti(d,\tau)^{45}Sc$ reaction has been investigated at an incident energy of 52 MeV. Angular distributions have been taken for 14 τ-groups corresponding to excitation energies below 4 MeV in ^{45}Sc. Spectroscopic factors were extracted through DWBA calculations. Spins and parities of $5/2^+$ are proposed for states at 1.30, 1.80, 2.91, 3.48, and 3.72 MeV. The hole state spectrum of ^{45}Sc closely resembles that of ^{47}Sc. A strong fractionation of the $1d_{3/2}$ strength was not observed in contrast to other recent work. The data provide evidence for $(1f^5_{7/2} \cdot 1f^1_{7/2})$ components in the ground state wave function of ^{46}Ti, which demonstrates that such configurations are not restricted to neutron excitations. (auth)

34873 SEARCH FOR MULTIPARTICLE–MULTIHOLE STATES OF ^{40}Ca WITH THE $^{32}S(^{12}C,\alpha)$ REACTION. Middleton, R.; Garrett, J. D.; Fortune, H. T. (Univ. of Pennsylvania, Philadelphia). Phys. Lett.; 39B: No. 3, 339-42(1 May 1972).

Levels of ^{40}Ca below E_x = 10 MeV have been populated with the $^{32}S(^{12}C,\alpha)$ reaction at an incident energy of 30 MeV. States which are thought to be based on 4p-4h and 8p-8h K = 0 configurations were more strongly populated than other low-lying states. (auth)

34874 ^{56}Fe AND ^{58}Fe(n,p) CROSS SECTIONS FOR 14.4 MeV NEUTRONS. Dyer, N. C.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Contract AT(40-1)-2701. J. Inorg. Nucl. Chem.; 34: No. 4, 1119-20(Apr 1972).

The (n,p) cross sections of ^{56}Fe and ^{58}Fe for 14.4 MeV neutrons were measured to be 109 ± 10 and 10.8 ± 1.0 mbarn, respectively. The ^{58}Mn activity had a half-life of 65.3 ± 0.7 sec. (auth)

34875 GENERALIZED BARDEEN–COOPER–SCHRIEFFER AND SELF-CONSISTENT HARTREE–FOCK–BOGOLYUBOV APPROXIMATIONS. Chandra, Harish; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., C; 5: No. 5, 1791-4 (May 1972).

Calculations using the self-consistent Hartree–Fock–Bogolyubov (HFB) theory are carried out for even Ti isotopes, and the results are compared with those obtained from the generalized BCS approximation of Belyaev for axially symmetric deformation. It is found that in most cases the generalized BCS and HFB results agree; however, for isotopes for which the generalized BCS and Hartree–Fock results agree, the HFB approximation may yield a different solution with the same energy minimum having different pairing correlations. (3 tables) (auth)

34876 2.335-MeV ISOBARIC ANALOG RESONANCE IN ^{51}V + p AND THE EXCITED STATES OF ^{51}Cr STUDIED VIA THE (p,n) AND (p,nγ) REACTIONS. Egan, J. J.; Sekharan, K. K.; Dutt, G. C.; Wiest, J. E.; Gabbard, F. (Univ. of Kentucky, Lexington). Phys. Rev., C; 5: No. 5, 1562-72(May 1972).

The 2.335-MeV isobaric analog resonance in $^{51}V(p,n)^{51}Cr$ and $^{51}V(p,p)^{51}V$ was studied experimentally. Detailed analysis was not possible because of the complexity of the excitation function in this energy region. $^{51}V(p,n)^{51}Cr$ angular distributions at 4.013- and 5.016-MeV bombarding energies were analyzed via statistical-model formalism. Twelve states in ^{51}Cr were observed up to an excitation energy of 2.39 MeV. The γ rays from the transitions (777 → 749 keV) and (749 keV → ground state) were observed, and their angular distributions were determined to be isotropic. Angular distributions of the 1165-, 1480-, and 2001-keV γ rays leading to the ground state of ^{51}Cr were measured at proton bombarding energies of 4.0 and 4.4 MeV. Spins of $9/2^-$ and $11/2^-$ are assigned to the 1165- and the 1480-keV levels, respectively, in agreement with other investigators. The angular distribution for the 2001-keV level is isotropic, this result indicating a spin of $1/2$ or less. Higher excited states in ^{51}Cr were observed through the (p,n) reaction at 2256, 2313, and 2380 keV. The (p,n) yield coupled with the failure to observe the ground-state transition from the 2256-keV level in the γ-ray spectra indicates that the spin of this level is greater than $13/2$. (12 figures, 3 tables) (auth)

34877 SPINS OF ^{42}K STATES BY GAMMA–GAMMA CORRELATIONS. Spyr, D. J.; Carpenter, R. T. (Univ. of Iowa, Iowa City). Phys. Rev., C; 5: No. 5, 1576-81(May 1972).

Gamma–gamma angular correlations were measured for γ rays resulting from transitions in ^{42}K which was formed by 6-MeV deuteron bombardment of separated ^{41}K. Litherland and Ferguson's Method I was used to study the cascade γ rays from the 252- and 104-keV states. Acceptable spin sequences of 432 and 322, respectively, were found. Mixing ratios and population parameters are given. (6 figures, 1 table) (auth)

34878 REACTION ^{42}Ca(p,t)^{40}Ca AT 40 MeV. Schapira, J. P. (Institut de Physique Nucleaire, Orsay, France); Chabre, M.; Dupont, Y.; Martin, P. Phys. Rev., C; 5: No. 5, 1593-9 (May 1972).

The reaction ^{42}Ca(p,t)^{40}Ca at 40 MeV incident energy was used to excite the following levels: g.s. (0^+), 3.352 (0^+), 3.734) (3^-), 3.903 (2^+), 4.487 (5^-), 5.25 ($0^+,2^+,4^+$), 6.51 ± 0.01, 6.62 ± 0.02, 6.945 ± 0.015, 7.575 ± 0.015, 7.69 ± 0.03 (3^-, T = 1), 8.41 ± 0.03, 8.57 ± 0.02, 9.11 ± 0.02, and 9.30 ± 0.03. Results on the first two 0^+ states are compared with theoretical predictions. There is no evidence for a 2p−2h, 0^+, T = 0 state at an excitation $\lesssim$8 MeV; this finding suggests a fragmentation of this strength and/or that this state is higher in energy. A previously unreported $(2p-2h)^{J=0^+,T=1}$ state was observed at 9.30 ± 0.03 MeV. These results suggest that the monopole force discussed by Zamick is less isospin-dependent in the Ca region than is usually admitted. (3 figures, 3 tables) (auth)

34879 STUDY OF ^{57}Co WITH THE ^{56}Fe(^{3}He,d) AND ^{56}Fe(^{3}He,dγ) REACTIONS. Hardie, G. (Western Michigan Univ., Kalamazoo. Argonne National Lab., Ill.). Braid, T. H.; Meyer-Schuetzmeister, L.; Smith, J. W. Phys. Rev., C; 5: No. 5, 1600-13(May 1972).

About 65 levels in ^{57}Co were populated by the ^{56}Fe(^{3}He,d) reaction. The angular distributions of deuterons leading to many of these states were obtained with a split-pole magnetic spectrograph. In many cases, comparison of these angular distributions with distorted-wave Born-approximation calculations permitted both the determination of the angular momentum of the transferred proton and the transition strength. These results are compared with previous work. Coincidences between deuterons and γ rays from the ^{56}Fe(^{3}He,dγ) reaction were also studied to obtain the γ decay of some levels in ^{57}Co. The possibility of pairs of closely spaced levels, which has been suggested as an explanation for the discrepancies in some spin and parity assignments, was also investigated. Theoretical calculations are briefly compared with some of the existing experimental results on excited states in ^{57}Co. Finally, the question of which states in ^{57}Co are analogs of low-lying states in ^{57}Fe is discussed. (9 figures, 5 tables) (auth)

34880 NUCLEAR STRUCTURE INFORMATION FROM HIGH-ENERGY (p,2p) EXPERIMENTS. Elton, L. R. B. (Univ. of Surrey, Eng.); Sundberg, O. Nucl. Phys.; A187: No. 2, 314-22(1972).

A re-analysis of the data on the reaction ^{40}Ca(p,2p)^{39}K at 460 MeV shows that information can be obtained regarding the shapes and widths of the peaks in the energy spectrum for the knock-out of a $1d_{5/2}$, 2s and $1d_{3/2}$ proton. The separation of the peaks is in good agreement with other evidence, and the differential cross section for the $1d_{3/2}$ knock-out is in reasonable agreement with a calculation based on single-particle wave functions obtained from electron scattering. (auth)

34881 γ-RAY DECAY PROPERTIES OF ANALOGUE STATES OF ^{55}Fe EXCITED IN THE REACTION ^{54}Fe(p,γ)^{55}Co. Martin, D. J.; Leslie, J. R.; McLatchie, W.; Monahan, C. F.; Carlson, L. E. (Queen's Univ., Kingston, Ont.). Nucl. Phys.; A187: No. 2, 337-54(1972).

Gamma-ray angular distribution, polarization and resonance strength measurements have been carried out on resonances observed in the reaction ^{54}Fe(p,γ)^{55}Co at proton energies of 1803 and 1887 keV. These resonances at excitation energies of 6833 and 6916 keV in ^{55}Co have $J^\pi = (3/2^-)$ and $5/2^-$ and resonance strengths of $(2J+1)\Gamma_\gamma \Gamma_p/\Gamma = 0.98$ and 0.45 eV respectively. These resonance states have been identified as analogs of the 2050 keV ($J^\pi = 3/2^-$) and 2144 keV ($5/2^-$) states in ^{55}Fe. A state at 4722 keV ($3/2^-$) has been identified as the analog of the ground state of ^{55}Fe. Transition probabilities for γ-rays de-exciting these analog states are examined. Although no strong analog-antianalog transitions from the resonance levels are observed there are strong transitions between the analog states and also from the analog of the ^{55}Fe ground state to a T = ½ state in ^{55}Co. (auth)

34882 INELASTIC SCATTERING OF 12.8 MeV DEUTERONS FROM ^{39}K NUCLEI. Elbek, B. (Univ. of Copenhagen); Budzanowski, A.; Grotowski, K.; (and others). Nucl. Phys.; A187: No. 2, 355-68(1972).

The cross sections for the elastic and inelastic scattering of 12.8 MeV deuterons by ^{39}K have been measured by means of a broad-range magnetic spectrograph. Angular distributions from 20° to 145° were obtained for deuterons inelastically scattered to the 2.53, 2.82, 3.02, 3.60, 3.88, 3.94, 4.08 + 4.09, 4.12, 4.51 and 5.17 MeV states in ^{39}K. These cross sections are analyzed with the DWBA theory, and the angular momentum transfer and dynamical deformation parameters are determined. A discussion of the structure of the ^{39}K levels in terms of the excited core model is given. (auth)

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Refer also to abstracts 33532, 34027, 34552, 34851, 34852, and 34960.

34883 (BARC-566) CORE EXCITED STATES IN ^{73}Ge. Betigeri, M. G.; Lamba, C. M.; Sood, D. K.; Thampi, N. S. (Bhabha Atomic Research Centre, Bombay (India)). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The low lying states of ^{73}Ge have been excited as isobaric analogue states in ^{73}As by the proton bombardment of ^{72}Ge. The decay of these states to the 0_2^+ in ^{72}Ge at 690 keV has been observed and the accompanying conversion electrons have been detected using an Orange spectrometer. The excitation function covers isobaric analogue states of ^{73}Ge up to an excitation of 1.32 MeV. From the measurement of the total inelastic cross section the values for partial width for the states have been calculated. The results indicate that the states at 570, 930 and 1274 keV in ^{73}Ge are mainly built on 0_2^+ and 67, 864 and 1051 keV levels have significant contribution from both the ground and the first excited states of ^{72}Ge. (auth)

34884 (KHFTI-71-27) PROTON CAPTURE COEFFICIENTS FOR STABLE NUCLEI FROM ^{55}Mn TO ^{71}Ga. Mishchenko, V. M.; Timoshevskii, G. F.; Storizhko, V. E. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1971. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

Proton capture coefficients were computed from an optical nuclear model neglecting the spin-orbital interaction for stable nuclei from ^{55}Mn to ^{71}Ga over the range of proton energies from 2 to 10 MeV at intervals of 0.5 MeV. The computed values are presented in normalized form. (K.S.W.)

34885 0^+ STATES IN Ni-ISOTOPES DESCRIBED BY THE BROKEN-PAIR APPROXIMATION AND THE GENERATOR COORDINATE METHOD. Siegal, C. D.; Gambhir, Y. K. (Carnegie-Mellon Univ., Pittsburgh). Phys. Lett.; 39B: No. 2, 151-5 (17 Apr 1972).

Two distinct methods, the broken-pair approximation (BPA) and the generator coordinate method (GCM), are compared for the 0^+ states of Ni isotopes. The states are obtained in terms of valence neutrons occupying $2p_{3/2}$, $1f_{5/2}$, $2p_{1/2}$, and $1g_{9/2}$ single-particle levels outside the assumed N = Z = 28 inert core by using (a) the pairing force and (b) the renormalized nonlocal separable Tabakin interaction. The ground-state properties are discussed. The resulting wave functions are used to calculate the angular distribution, total cross section, and related quantities for two-nucleon transfer reactions. The analysis of the results points toward the requirements for the applicability of these methods. (auth)

34886 l_n-DEPENDENCE OF EXCITATION FUNCTIONS FOR THE ^{89}Y(d,p)^{90}Y REACTION BELOW THE COULOMB BARRIER. Yamaya, T. (Tohoku Univ., Sendai); Horiguchi, T.; Morita, S.; Miura, K. Phys. Lett.; 39B: No. 2, 182-4(17 Apr 1972).

The l_n dependence of excitation functions for the reaction ^{89}Y(d,p)^{90}Y was studied for $E_d = 3.0$ to 4.5 MeV at $\theta = 150°$. The 2.94- and 3.05-MeV excited states in ^{90}Y are fitted well with $l_n = 4$, and are assigned $J^\pi = 4^-$ and 3^-, respectively. They form the doublet of the configuration $(2p_{1/2})_p\ (1g_{9/2})_n$. (auth)

34887 14.8 MeV NEUTRON ACTIVATION CROSS SECTIONS OF RUBIDIUM, STRONTIUM, ZIRCONIUM, NIOBIUM, AND RARE-EARTH NUCLIDES. Bari, Abdul. Fayetteville, Ark.; Univ. of Arkansas (1972). 79p. University Microfilms Order No. 72-10,198.

Thesis.

Activation cross sections for rubidium, strontium, zirconium, niobium and rare-earth nuclides have been measured with 14.8 MeV neutrons. The radioactivity measurements were carried out with a Ge(Li) detector. The cross sections measured, in millibarns, are: ^{85}Rb(n,p)^{85m}Kr, 6 ± 1; ^{87}Rb(n,p)^{87}Kr, 7 ± 1; ^{86}Sr(n,p)^{86m}Rb, 9 ± 1; ^{88}Sr(n,p)^{88}Rb, 20 ± 2; ^{90}Zr(n,p)^{90m}Y, 13 ± 1; ^{139}La(n,p)^{139}Ba, 6.0 ± 0.6; ^{140}Ce(n,p)^{140}Ba, 8.1 ± 0.8; ^{141}Pr(n,p)^{141}Ce, 11.4 ± 1.1; ^{146}Nd(n,p)^{146}Pr, 2.9 ± 0.3; ^{150}Sm(n,p)^{150}Pm, 7.0 ± 0.6; ^{153}Eu(n,p)

^{153}Sm, 4.4 ± 0.5; ^{159}Tb(n,p)$^{159(m+g)}$Gd, 6.6 ± 0.7; ^{166}Er(n,p)^{166}Ho, 2.3 ± 0.2; ^{174}Yb(n,p)^{174}Tm, 3.9 ± 0.4; ^{90}Zr(n,α)^{87m}Sr, 4.6 ± 0.5; ^{93}Nb(n,α)^{90m}Y, 5.8 ± 0.5; ^{139}La(n,α)^{136}Cs, 2.5 ± 0.3; ^{142}Ce(n,α)^{139}Ba, 6.5 ± 0.8; ^{142}Nd(n,α)^{139}Ce, 7.1 ± 0.8; ^{150}Sm(n,α)^{147}Nd, 3.5 ± 0.5; ^{152}Sm(n,α)^{149}Nd, 1.7 ± 0.2; ^{154}Sm(n,α)^{151}Nd, 0.86 ± 0.09; ^{162}Dy(n,α) ^{159}Gd, 2.1 ± 0.2; ^{85}Rb(n,2n)^{84m}Rb, 714 ± 50; ^{85}Rb(n,2n)^{84g}Rb, 621 ± 75; ^{85}Rb(n,2n)$^{84(m+g)}$Rb, 1335 ± 90; ^{87}Rb(n,2n)^{86m}Rb, 584 ± 40; ^{87}Rb(n,2n)^{86g}Rb, 833 ± 60; ^{87}Rb(n,2n)$^{86(m+g)}$Rb, 1417 ± 72; ^{84}Sr(n,2n) ^{83}Sr, 395 ± 75; ^{86}Sr(n,2n)^{85m}Sr, 360 ± 30; ^{88}Sr(n,2n)^{87m}Sr, 344 ± 30; ^{90}Zr(n,2n)^{89m}Zr, 143 ± 15; ^{90}Zr(n,2n)^{89g}Zr, 342 ± 25; ^{90}Zr(n,2n) $^{89(m+g)}$Zr, 485 ± 29; ^{93}Nb(n,2n)^{92m}Nb, 455 ± 32; ^{136}Ce(n,2n)^{135}Ce, 1623 ± 154; ^{138}Ce(n,2n)^{137m}Ce, 1055 ± 100; ^{140}Ce(n,2n)^{139m}Ce, 986 ± 111; ^{140}Ce(n,2n)$^{139(m+g)}$Ce, 1880 ± 176; ^{142}Ce(n,2n)^{141}Ce, 2008 ± 193; ^{141}Pr(n,2n)^{140}Pr, 1152 ± 121; ^{142}Nd(n,2n)^{141m}Nd, 697 ± 91; ^{142}Nd(n,2n) $^{141(m+g)}$Nd, 2039 ± 192; ^{148}Nd(n,2n)^{147}Nd, 1385 ± 128; ^{150}Nd(n,2n) ^{149}Nd, 1766 ± 164; ^{144}Sm(n,2n)^{143m}Sm, 521 ± 81; ^{144}Sm(n,2n)^{143g}Sm, 402 ± 57; ^{144}Sm(n,2n)$^{143(m+g)}$Sm, 923 ± 99; ^{154}Sm(n,2n)^{153}Sm, 1575 ± 143; ^{151}Eu(n,2n)^{150g}Eu, 497 ± 45; ^{153}Eu(n,2n)^{152m_1}Eu, 263 ± 25; ^{153}Eu(n,2n)^{152m_2}Eu, 52 ± 4; ^{160}Gd(n,2n)$^{159(m+g)}$Gd, 2955 ± 250; ^{156}Dy (n,2n)^{155}Dy, 1982 ± 178; ^{158}Dy(n,2n)^{157}Dy, 2115 ± 190; ^{162}Er(n,2n) ^{161}Er, 1527 ± 150; ^{169}Tm(n,2n)^{168}Tm, 1443 ± 129; ^{168}Yb(n,2n)^{167}Yb, 1873 ± 201; and ^{170}Yb(n,2n)$^{169(m+g)}$Yb, 2015 ± 150. The measured cross sections are compared with the semiempirical predictions of Levkovskii, Bayhurst and Prestwood, Gardner, and Pearlstein. The shell closure effects have been reexamined in light of the present data. (Diss. Abstr. Int., B)

34888 EXCITED STATES OF ^{79}Kr OBSERVED IN THE DECAY OF ^{79}Rb. Broda, R. (Inst. of Nuclear Physics, Krakow); Rybicka, M.; Styczen, J.; Walus, W.; Krolas, K. Acta Phys. Pol., B3: No. 2, 263-81(Mar-Apr 1972).

The level scheme of ^{79}Kr was investigated from the decay of 23.8 min ^{79}Rb. Using Ge(Li) detectors and scintillator NaJ(Tl) counters single, prompt coincidence and delayed coincidence spectra were measured. For the 146.8 keV state the value of the life time of (79.1 ± 1.5) nsec was obtained, which is in good agreement with previous results, and for the 182.3 keV state the upper limit of 0.6 nsec was estimated. From the end-point energies of positron spectra in coincidence with prominent γ-rays the decay energy of (3726 ± 60) keV of ^{79}Rb was determined. The proposed level scheme of ^{79}Kr incorporates all the observed transitions except four weak ones. The log ft values (or their limits) were determined for β transitions to the excited states of ^{79}Kr. The results of this work are compared with those of Lingemann et al. and differences in the spin assignments of some excited states of ^{79}Kr and of the ground state of ^{79}Rb are discussed. A comparison of the low-lying states of ^{79}Kr and ^{77}Se is made and a description of some excited states in the framework of the Nilsson model is also discussed. (auth)

34889 AFTER-EFFECTS IN THE DECAY OF ^{75}As AND ^{197m}Hg. Baeverstam, U.; Othaz, R.; de Sousa, N.; Ringstroem, B. (Univ. of Stockholm). Nucl. Phys.; A186: No. 3, 500-12(1972).

After-effects following internal conversion processes in the decay of ^{75}Se and ^{197m}Hg are investigated. Time differential electron-γ and time integral electron-γ, γ-electron and γ-γ directional correlation measurements are performed, and a magnetic decoupling technique is used. For certain insulating source backing materials after-effects are found. Relaxation time constants for the time-dependent perturbation and recombination time constants for the ionized atoms, as well as the strength of the time-dependent internal magnetic fields are deduced. (auth)

34890 STRUCTURE OF ^{62}Zn STUDIED THROUGH THE (p,t) REACTION AT 27.5 MeV. Farwell, L. C.; Kraushaar, J. J.; Baer, H. W. (Univ. of Colorado, Boulder). Nucl. Phys.; A186: No. 3, 545-60(1972).

Levels of ^{62}Zn were investigated via the (p,t) reaction at 27.5 MeV with excitation energies up to 5.4 MeV being measured for 18 levels, most of which are newly reported. The ground state Q-value was determined to be −12.493 ± 0.010 MeV. Angular distributions were measured in the angular range 8°−110° (lab). Spin-parity assignments are made by comparing the shapes of the angular distributions with zero-range DWBA calculations and with empirical characteristic shapes determined in earlier studies. Of particular interest are the new 0^+ states at 3.98 and 4.57 MeV and the strongly excited 4^+ states at 3.216, 4.17 and 5.37 MeV. A state at 2.74 MeV is tentatively identified as the low-lying octupole state. A careful search for the 0^+ member of the two-phonon triplet near 2 MeV excitation, suggested from other Zn isotopes, revealed no 0^+ state below 3.9 MeV excitation. (auth)

34891 DECAY OF ^{63}Co. Jongsma, H. W.; Kamermans, R.; Verheul, H. (Vrije Univ., Amsterdam). Z. Phys.; 251: No. 5, 425-30(1972).

The energies and relative intensities of the γ-rays from the decay of ^{63}Co (27.5 ± 0.3 sec) have been measured. New γ-transitions of 155.6, 913.6, 981.7, 1069.1 and 2174.5 keV have been observed and assigned to this decay. (auth)

34892 DECAY OF ^{61}Zn AND ^{60}Zn USING MASS-SEPARATED SOURCES. Dulfer, G. H.; ten Brink, B. O.; Ketel, T. J.; Kalshoven, A. W. B.; Verheul, H. (Vrije Univ., Amsterdam). Z. Phys.; 251: No. 5, 416-24(1972).

The γ-ray spectrum of ^{61}Zn and ^{60}Zn was studied with a 75 cm^3 Ge(Li) detector using mass separated sources. For the half-lives $T_{1/2}$(^{61}Zn) = 89.1 ± 0.2 sec and $T_{1/2}$(^{60}Zn) = 2.33 ± 0.05 min were found together with the values $T_{1/2}$(^{61}Cu) = 3.26 ± 0.05 hr and $T_{1/2}$(^{60}Cu) = 24.0 ± 0.3 min for the half-lives of the daughter activities. (auth)

34893 NEUTRON–GAMMA COMPETITION FOLLOWING (d,d') REACTIONS. Ling, C.; Bodansky, D.; Calarco, J. R.; Cameron, J. M. (Univ. of Washington, Seattle). Phys. Rev., C; 5: No. 5, 1622-40(May 1972).

The (d,d'n) reaction was studied in ^{61}Ni and other targets by using 19-MeV deuterons. Deuteron angular distributions and yields indicate that the (d,d') reaction is predominantly direct at forward angles, but probably has a large compound-nuclear component at backward angles; observed angular correlations for d'−n coincidences indicate that the neutrons are mainly products of evaporation from a ^{61}Ni compound nucleus. The fractional yield, $F_n = \Gamma_n/\Gamma$, for neutron emission is found to be substantially below unity for ^{61}Ni excitation energies, E_i, extending to several MeV above the neutron binding energy, B_n (e.g., $F_n \simeq 0.75$ at $E_i - B_n = 2$ MeV; this decrement indicates the importance of competition from γ-ray emission. For $E_i - B_n < 3$ MeV, F_n is independent of deuteron angle and its magnitude can be accounted for in terms of the statistical model. Because the relative neutron and γ-ray emission widths are strongly dependent on the ^{61}Ni spin population, this lack of dependence of F_n on deuteron detection angle suggests that the ^{61}Ni spin population is similar for direct and compound-nuclear (d,d') reactions. For $E_i - B_n > 3$ MeV, the value of F_n at forward deuteron angles is anomalously low. Results are also presented for the (d,d'n) reaction in ^{25}Mg, ^{57}Fe, ^{91}Zr, and ^{119}Sn. (18 figures) (auth)

34894 SUMMING-ENERGY SPECTRUM OF THE BETA PARTICLES PLUS EMITTED K ELECTRONS IN THE K-SHELL INTERNAL IONIZATION ACCOMPANYING THE BETA DECAY OF ^{63}Ni. Kitahara, Tetsuo; Isozumi, Yasuhito; Shimizu, Sakae (Kyoto Univ.). Phys. Rev., C; 5: No. 5, 1810-13(May 1972).

Through a new type of experiment to obtain information on the K-shell internal ionization in β decay, the summing-energy spectrum of electrons (β particles plus emitted K-shell electrons) in coincidence with emitted K x rays in the β decay of ^{63}Ni was observed directly by using two proportional counters. The procedure and results are discussed. (3 figures) (auth)

34895 STUDY OF CORE COUPLING IN ^{87}Rb THROUGH ISOBARIC-ANALOG RESONANCES. I. Hollas, C. L.; Hiddleston, H. R.; Mistry, V. D.; Sen, S.; Riley, P. J. (Univ. of Texas, Austin). Phys. Rev., C; 5: No. 5, 1641-5(May 1972).

Isobaric-analog resonances were observed in proton elastic scattering by ^{86}Kr at proton energies from 4.76 to 10.10 MeV. The observed resonances in ^{87}Rb were identified as analogs of low-lying states of ^{87}Kr. The data were analyzed using a shell-model description of isobaric-analog resonances. Orbital-angular-momentum-transfer values, resonance energies, total and partial widths, and spectroscopic factors for 14 of the observed resonances are presented. The results are shown to be in good overall agreement with (d,p) studies on the target nucleus. (auth)

34896 STUDY OF CORE COUPLING IN ^{87}Rb THROUGH ISOBARIC-ANALOG RESONANCES. II. Hollas, C. L.; Hiddleston, H. R.; Mistry, V. D.; Sen, S.; Riley, P. J. (Univ. of Texas, Austin). Phys. Rev., C; 5: No. 5, 1646-57(May 1972).

The level structure of the ^{86}Kr−^{87}Kr system was investigated by means of the inelastic scattering of protons through isobaric-analog resonances (IAR's). Twenty-four levels in ^{86}Kr between 1.55 and 5.07 MeV were identified in the spectra. Excitation-function data indicate that coupling of the $d_{5/2}$ single particle to excited states of ^{86}Kr provides important contributions to the wave function of the IAR's. The coefficients describing the coupling of single-particle states to the excited core states in ^{86}Kr were extracted from the angular-distribution measurements of the inelastic proton decay of the 5.348-, 6.826-, and 8.374-MeV IAR's. The inclusion of these coefficients together with previously deduced elastic spectroscopic factors allows a rather full description of the wave functions for the parent analog states of these IAR's. A calculation of the wave functions and binding energies in terms of a simple core-coupling model was performed for the d and s states in ^{87}Kr. The calculation shows good agreement with the results of the analysis of the proton decay of the IAR for the low-lying states. (10 figures, 6 tables) (auth)

34897 LEVELS OF ^{86}Kr FED IN THE DECAY OF ^{86}Br. Achterberg, E.; Iglesias, F. C.; Jech, A. E.; (and others) (Departamento de Fisica Nuclear, Buenos Aires). Phys. Rev., C; 5: No. 5, 1587-92(May 1972).

The decay of ^{86}Br was studied with high-resolution Ge(Li) detectors by applying on-line mass-separation techniques to ^{235}U fission products. Nineteen transitions were positively assigned to this decay through half-life comparisons, and for 10 of them direct measurements of the half-life were performed, an average value of 59 ± 4 s being found. Levels for ^{86}Kr are proposed at (J^{π} within parentheses) 1564.62 ± 0.09 keV (2^+), 2349.60 ± 0.14 keV (1,2), 2850.2 ± 0.4 keV, 2926.24 ± 0.13 keV (1,2), 3099.20 ± 0.16 keV (3^-), 4315.75 ± 0.17 keV (2^-,3^-), 5406.6 ± 0.5 keV (1,2), 5519.0 ± 0.9 keV (1^-,2^-), and 6209.9 ± 0.5 keV (1^-,2^-). (3 figures, 2 tables) (auth)

34898 TRANSITION RATES IN ^{89}Zr. Gill, R. D.; Caraca, J. M. G.; Cox, A. J.; Rose, H. J. (Oxford Univ.). Nucl. Phys.; A187: No. 2, 369-78(1972).

The lifetimes of a number of levels in ^{89}Zr have been measured with the Doppler-shift attenuation method using the ^{89}Y(p,nγ)^{89}Zr reaction and observing the γ-rays in a Ge(Li) detector. The results are: $\tau(1628) = 370 \pm 50$ fs, $\tau(1743) = 710 \pm 180$ fs, $\tau(1835) = 460 \pm 190$ fs, $\tau(2100) = 180 \pm 60$ fs, $\tau(2298) = 105 \pm 30$ fs, $\tau(2388) = 180 \pm 60$ fs and $\tau(2572) = 130 \pm 30$ fs. Level decay modes are also reported. The level at 2.13 MeV was found to be a doublet and a new level was found at 2568 keV. (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 34850, 34852, 34886, 34887, 34893, 34901, 34960, 34966, 34983, and 35034.

34899 (ORO–2434-8) EXPERIMENTAL STUDY OF NUCLEAR MODELS. I. DECAY SCHEMES AND NUCLEAR REACTIONS. II. MUONIC X-RAY STUDIES. Progress Report, August 1, 1971–July 31, 1972. Sheline, Raymond K.; Griffioen, Roger D. (Florida State Univ., Tallahassee). 1972. Contract AT(40-1)-2434. 36p. Dep. NTIS.

Research progress which compares current nuclear models with reaction spectroscopy is summarized. The shell model is compared with a series of even Ce isotopes, with the low-lying levels and configurations in ^{210}Bi and with the low-lying states and configurations in ^{138}La. The deformed nuclei considered are ^{153}Sm, ^{158}Gd and ^{168}Tm. The emphasis on coriolis coupling in both the odd-A and even-A species is discussed. Finally, transitional nuclei in the Ru-Pd and neutron deficient Ba regions are considered. Theoretical research on the nucleus ^{16}O assuming tetrahedral deformation is shown to be an interesting bridge between models. A brief description of some initial work in the muonic x-ray field is presented. Finally, a discussion of work in ^{13}C substitution in the metal carbonyls and work on the synthesis of uranium carbonyls at low temperature is described. (auth)

34900 EXCITED STATES OF ^{98}Rh AND ^{99}Rh FOLLOWING THE DECAY OF Pd ISOTOPES. Gasior, M.; Potempa, A. W.; Roth, H.; Sieniawski, J. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., B3: No. 2, 153-62(Mar-Apr 1972).

Energies and intensities of conversion electron spectra from ^{38}Pd and ^{99}Pd decays were measured with a magnetic beta-ray spectrometer. Gamma spectra were obtained by the use of a Ge (Li) detector. Schemes of the low excited states of ^{98}Rh and ^{99}Rh are suggested. (auth)

34901 ^{90}Zr(d,p)^{91}Zr REACTION WITH HIGH RESOLUTION. Graue, A. (Univ. of Bergen, Norway); Herland, L. H.; Lervik, K. J.; Nesse, J. T.; Cosman, E. R. Contract AT(30-1)2098. Nucl. Phys.; A187: No. 1, 141-52(1972).

The ^{90}Zr(d,p)^{91}Zr reaction has been studied at a bombarding energy of $E_d = 7.5$ MeV with high resolution. A total of 89 levels of ^{91}Zr have been seen below $E_x = 6.5$ MeV compared to the about 36 levels known previously in the same range. Complete angular distributions have been measured in a multiple-gap spectrograph for many of the transitions. A DWBA analysis has been carried out for those distributions showing stripping patterns. Spectroscopic factors, summed strengths, and single-particle energy centroids are deduced. The results are compared to other data on this nucleus. (auth)

34902 ANALYSIS OF PHOTONUCLEAR YIELD CURVES. Bramanis, E.; Deague, T. K.; Hicks, R. S.; (and others) (Univ. of Melbourne, Parkville, Australia). Nucl. Instrum. Methods; 100: No. 1, 59-71(1972).

Currently used methods of photonuclear yield curve analysis are critically examined. The results of extensive computer tests designed to study the characteristics of different analysis methods and the effects of statistics and the X-ray spectrum are presented. These permit critical evaluations of the significance of structure in cross sections to be made and the possibility of systematic errors in overall cross section shapes to be assessed in specific instances. A significant modification of the Penfold–Leiss method is described in which the analysis bin width varies in accordance with a statistical criterion over the energy range of a yield curve. This procedure is known to have advantages over previously used methods. (auth)

34903 PHOTONUCLEAR EXPERIMENTS USING COMBINED ENERGY AND INTENSITY SWEEPING. Thies, H. H.; Crawford, D. M.; Koch, R.; Thomas, B. W. (Univ. of Western Australia, Nedlands). Nucl. Instrum. Methods; 100: No. 1, 45-58(1972).

Accuracy and resolution of photonuclear bremsstrahlung experiments can be improved by using combined "energy and intensity sweeping". This means that accelerator energy and intensity are changed with each accelerator pulse according to a repetitive pattern, and has the beneficial effect of greatly reducing systematic cross-section errors. The method and its limits are demonstrated by a universal model experiment (A = 100). (auth)

34904 14.6 ± 0.5 YEAR HALF-LIFE OF ^{113m}Cd. Wahl, A. C. (Los Alamos Scientific Lab., N. Mex.). J. Inorg. Nucl. Chem.; 34: No. 5, 1767-8(May 1972).

The decay of ^{113m}Cd in samples used previously (1959) to establish the 14 ± 2 yr half-life value and the mass-number assignment was followed for an additional eleven years on the same methane-flow beta proportional counter. The decay data were analyzed by the least squares program "SKITZO" with a CDC-6600 computer. The data are represented satisfactorily by one component; the half-life values determined for the five samples followed are tabulated. The square root of the sum of the squares of the uncertainties discussed in 3.4% of the half-life value, so the recommended value is 14.6 ± 0.5 yr. (UK)

34905 MAGNETIC MOMENT MEASUREMENTS OF THE FIRST (2^+) AND SECOND (4^+) STATES OF EVEN Nd AND Sm NUCLEI. Kugel, H. W. (Univ. of Wisconsin, Madison); Borchers, R. R.; Kalish, R. Nucl. Phys.; A186: No. 3, 513-27 (1972).

The ion-implantation perturbed angular correlation technique was used to measure γ-ray angular distributions from the decay of the first (2^+) and second (4^+) states of even Nd and Sm nuclei recoiled into polarized iron. These data and the results of previous measurements give values of $H_0 = 2.4 \pm 0.3$ MOe for H (NdFe), $H_0 = 2.3 \pm 0.2$ MOe for H(SmFe) and $H_t\tau_t = 10.8 \pm 8.9$ MOe · psec for the transient effect for Sm and Nd nuclei recoil implanted into polarized iron (300°K). The g-factor results for the first (2^+) states of ^{144,146,148}Nd and ^{148,150}Sm and for the second (4^+) states of ^{150}Nd and ^{152,154}Sm show a rather strong decreasing trend with decreasing neutron number. (auth)

34906 (t,p) REACTION ON THE EVEN ISOTOPES OF NEODYMIUM. Chapman, R. (Atomic Energy Research Establishment, Harwell, Eng. Atomic Weapons Research Establishment, Aldermaston, Eng.); McLatchie, W.; Kitching, J. E. Nucl. Phys.; A186: No. 3, 603-19(1972).

The Aldermaston multi-angle magnetic spectrograph and tandem Van de Graaff accelerator have been used to study the (t,p) reactions leading to the neodymium isotopes ^{144,146,148,150,152}Nd at a bombarding energy of 13 MeV. The Q-values were measured for final states with excitation energies up to about 3 MeV. From the shapes of the proton angular distributions a number of states with spin and parity $J^{\pi} = 0^+$ were identified. Assignment of spin to states with non-zero J-values from a visual inspection of the shapes of the distributions is found to be more difficult than for the spin-zero case. The results are discussed within the context of the change of nuclear coupling scheme near neutron number 90. (auth)

34907 MULTIPOLE MIXING RATIOS OF TRANSITIONS IN ^{124}Te. Baker, K. R.; Hamilton, J. H.; Ramayya, A. V.; Highland, G. (Vanderbilt Univ., Nashville). Nucl. Phys.; A186: No. 3, 493-9(1972).

Gamma-gamma directional correlation measurements were made on nine transitions in ^{124}Te with a NaI(Tl)–Ge(Li) detector arrangement and multichannel analysis. The multipole mixing ratios obtained were $\delta(646) = 0.000 \pm 0.001$, $\delta(714) = 1.5^{+0.6}_{-0.3}$, $\delta(723)$ -3.3 ± 0.2, $\delta(1437) = 3.7$, $\delta(1489) = -3.4$, $\delta(968) = -0.03$,

$\delta(1368) = -0.045 \pm 0.090$, $\delta(1045) = 0.041$, $\delta(1691) = -0.02 \pm 0.01$, and $\delta(2091) = 0.00$. The first δ is M3/E2, the next three are E2/M1, and the last five are M2/E1. The retardation (a factor of approximately 50) of the crossover to cascade transitions from the 2039 keV, third 2^+ level to the second and first 2^+ levels is essentially the same for both the M1 and E2 components. In addition, spin and parity assignments of 2^+ were made for the 2039 and 2092 keV levels. (auth)

34908 LEVELS OF ^{93}Zr POPULATED IN DECAY OF ^{93}Y. Ohya, Susumu (Tokyo Inst. of Tech.); Matumoto, Zyun-itiro. J. Phys. Soc. Jap.; 32: No. 5, 1422-9(May 1972).

The decay of ^{93}Y to the levels in ^{93}Zr has been investigated with the use of Ge(Li), Si(Li), NaI, plastic and anthracene detectors in singles and coincidence experiments. Gamma-ray energies and relative intensities were carefully determined. The resulting decay scheme consists of levels at 267.0, 946.1, 1425.5, 1449.8, 1469.5, 1650.4, 1827.1, 1908.8, 2183.7, 2457.7 and 2474.7 keV. Gamma-gamma directional correlation measurement has been performed for the 679.1–267.0 keV cascade; $A_2 = -0.0049 \pm 0.0213$ and $A_4 = 0.020 \pm 0.036$. The K conversion coefficient was determined for the 267.0 keV transition; $\alpha_k = 0.022 \pm 0.004$. The spin-parity of the 267.0 keV level has been determined to be $\frac{3}{2}+$. The proposed level scheme was compared with the prediction of current theoretical calculations. (auth)

34909 LIFETIME OF THE 23.8-keV STATE IN ^{119}Sn. Drost, H.; Weiss, W.; Weyer, G. (Freie Univ., Berlin). Z. Naturforsch.; 26a: No. 6, 1092-3(Jun 1971).

The half-life of the 23.8 keV state in ^{119}Sn has been re-measured by conversion electron- and X-ray-γ delayed coincidence techniques. The result is $T_{\frac{1}{2}} = 18.45 \pm 0.2$ ns. The K-conversion coefficient of the 65 keV transition was measured as $\alpha_K = 1860 \pm 150$. (auth)

34910 DECAY OF SAMARIUM ISOTOPES: ^{140}Sm, ^{141m}Sm, ^{142}Sm, AND $^{143(m+g)}$Sm. Dewanjee, M. K.; Preiss, I. L. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Inorg. Nucl. Chem.; 34: No. 4, 1105-17(Apr 1972).

The isotopes of ^{140}Sm, ^{141m}Sm, ^{142}Sm and $^{143(m+g)}$Sm were produced by the ^{144}Sm(γ,xn) reactions. The cross bombardment technique was used for studying only the $^{143(m+g)}$Sm isotopes. The decays of the isotopes through positron emission and γ-ray transition were followed with the Ge(Li) and plastic detectors. For the $^{143(m+g)}$Sm isotopes, end point energy was determined and coincidence measurements were performed by gating on 511-, 1057- and 1516-keV γ-rays. Photon energies associated with the half-lives of 14.82, 22.8, 72.5, 1.08 and 8.85 min were assigned to the isotopes ^{140}Sm, ^{141m}Sm, ^{142}Sm and $^{143(m+g)}$Sm, respectively. A decay scheme was proposed for the decay of $^{143(m+g)}$Sm. The cross sections of the ^{144}Sm(n,2n) ^{143}Sm and ^{143g}Sm reactions were determined as 429.5 and 661.2 m respectively. (auth)

34911 HALF-LIVES AND GAMMA RAYS OF TIN ISOTOPES OF MASSES 129, 130, 131, AND 132. Izak, T.; Amiel, S. (Soreq Nuclear Research Centre, Yavne, Israel). J. Inorg. Nucl. Chem.; 34: No. 5, 1469-77(May 1972).

The half-lives of fission-produced tin 129–132 were determined. The assignment of the different half-lives to the various tin isotopes was based on comparison with the literature values for half-lives, the energies as found by the ^{128,130}Te(d,^{3}He)^{127,129}Sb reactions, and yield calculations. The half-lives obtained were: 2.52 ± 0.12 min for ^{129}Sn; 3.69 ± 0.07 min for ^{130}Sn; 62.9 ± 2.5 sec for ^{131}Sn; 41.1 ± 1.3 sec for ^{132}Sn. The following gamma energies were found, (the abundances relative to the 192.2 keV line are given in brackets): for ^{129}Sn– 642.0 keV (16.9%); for ^{130}Sn–69.5 keV (32.1%), 192.2 keV (100%), 228.0 keV (27.1%), 435.0 keV (8.7%), 738.0 keV (9.9%) and 776.0 keV (43.4%); for ^{131}Sn– 448.4 keV (50.6%); for ^{132}Sn– 84.7 keV (63.5%), 245.8 keV (60.5%) and 340.0 keV (74.0%). (auth) (UK)

34912 VERY NEUTRON-DEFICIENT ISOTOPES OF Cs STUDIED BY ON-LINE ISOTOPE SEPARATOR TECHNIQUES. Ravn, H. L.; Sundell, S.; Westgaard, L. (CERN, Geneva). Phys. Lett.; 39B: No. 3, 337-8(1 May 1972).

Short-lived cesium isotopes have been studied by means of a new target and ion-source system. The Cs was produced by bombarding molten La with 600 MeV protons. The half-lives of $^{117-120}$Cs were determined, and the nuclides ^{118}Cs, and, tentatively, ^{116}Cs and ^{120}Cs identified as delayed-proton precursors. (auth)

34913 PROTON–NUCLEUS SCATTERING AND THE NUCLEAR FORWARD-SCATTERING AMPLITUDE. Keating, Michael P.; Wills, John G. (Indiana Univ., Bloomington). Phys. Rev., C; 5: No. 5, 1572-6(May 1972).

It is possible to extract the nuclear part of the forward-scattering amplitude from small-angle proton–nucleus elastic scattering. The process is complicated in practice by the effects of experimental errors and theoretical approximations. Optical-model calculations are done, for 14.5-MeV protons on ^{16}O, ^{40}Ca, and ^{90}Zr, to examine the effects of these uncertainties on the determination of the nuclear forward amplitude. (1 figure, 1 table) (auth)

34914 LIFETIME MEASUREMENTS IN $^{120\ 122}$Xe AND $^{126\ 128}$Ba. Kutschera, W.; Dehnhardt, W.; Kistner, O. C.; (and others) (Max Planck Institut fuer Kernphysik, Heidelberg. Univ., Heidelberg). Phys. Rev., C; 5: No. 5, 1658-62(May 1972).

The mean lifetime of a number of levels of the ground-state band in ^{120,122}Xe and the first 2^+ states in ^{126,128}Ba were measured with the recoil-distance Doppler-shift method. The nuclei were produced by (^{16}O,4n) reactions. The measured E2 transition strengths, which range from 50 to 100 Weisskopf units, support the assumption of a transitional character for this neutron-deficient region. The deduced deformation parameters are found to be in rather good agreement with the predictions of theoretical calculations and the phenomenological variable-moment-of-inertia model. (3 figures, 2 tables) (auth)

34915 CONVERSION-COEFFICIENT MEASUREMENTS AND SPIN–PARITY ASSIGNMENTS FOR EXCITED LEVELS IN $^{133\ 135\ 136}$Xe, $^{135\ 137\ 139}$Cs, AND ^{138}Ba. Achterberg, E.; Iglesias, F. C.; Jech, A. E.; (and others) (Departamento de Fisica Nuclear, Buenos Aires). Phys. Rev., C; 5: No. 5, 1759-85(May 1972).

Solid-state detectors were used to perform on-line measurements of γ-ray and conversion-electron intensities in ^{133,135,136}Xe, ^{135,137,139}Cs, and ^{138}Ba. Conversion coefficients were determined for 37 transitions. Log-ft values were calculated on the basis of reported level schemes. The deduced multipolarities and log-ft values were combined with published reaction and angular-correlation results to assign spins and parities to 24 excited levels of the mentioned nuclei. The obtained Jπ contributed 13 new experimentally well-defined β-transition probabilities to the systematics of this magnitude. In ^{136}Xe and ^{138}Ba, three levels with known half-lives were determined to be depopulated by pure-E2 transitions; the retardation factors as compared to the Weisskopf estimate were calculated. Apart from Jπ assignments, some additional minor contributions were made to the knowledge of the level structure in ^{138}Ba and ^{139}Cs. The number of possible spins and parities for some of the excited levels in the nuclei studied was reduced by analyzing the systematic trends of measured Jπ values in their neighborhood. No modelistic considerations were taken into account for this purpose. (16 figures, 11 tables, 88 references) (auth)

34916 PHOTOPROTON REACTION ON Sn ISOTOPES. Sugawara, M.; Shoda, K.; Saito, T.; (and others) (Tohoku Univ., Sendai). Phys. Rev., C; 5: No. 5, 1705-12(May 1972).

The photoproton spectra and the photoproton yield curves were measured for ^{116}Sn, ^{117}Sn, ^{118}Sn, ^{120}Sn, ^{122}Sn, and ^{124}Sn by using the electrodisintegration reaction. Several proton peaks through isobaric analog states were found in each proton spectrum. In ^{120}Sn it was found that 8.3- and 8.0-MeV proton groups were emitted from an analog state at 19.2 MeV. For the other isotopes the excitation energies of the analog states were also estimated by assuming the same decay mode as that of ^{120}Sn. The yield curves of protons with an energy from 5.1 to 10.2 MeV have two breaks at each isotope corresponding to isobaric analog states. The excitation energies and the integrated cross sections were also determined. (8 figures, 3 tables) (auth)

34917 EFFECT OF PRESSURE ON THE DECAY CONSTANT OF ^{99m}Tc. Mazaki, Hiromasa; Nagatomo, Tsuneto; Shimizu, Sakae (Kyoto Univ.). Phys. Rev., C; 5: No. 5, 1718-24(May 1972).

An experimental investigation of the influence of high hydrostatic pressure on the decay constant of ^{99m}Tc was performed. By the use of a multianvil high-pressure apparatus, a carrier-free source of ^{99m}Tc was compressed at a pressure of 100 kbar. The observed decay rate of the compressed ^{99m}Tc source was compared with that of a standard ^{99m}Tc source in the normal uncompressed state. The fractional increase in the decay constant, $\Delta\lambda/\lambda$, of the compressed ^{99m}Tc under that pressure was found to be $(4.6 \pm 2.3) \times 10^{-4}$. The result agrees with that observed by Bainbridge, $\Delta\lambda/\lambda = (2.3 \pm 0.5) \times 10^{-4}$, to within a factor of about 2. Comparison with theoretical studies by other workers is also discussed. (6 figures) (auth)

34918 (^{3}He,d) STRIPPING TO UNBOUND ANALOG STATES IN Tc ISOTOPES. Ashery, D. (Tel-Aviv Univ., Israel); Alper, S.; Moalem, A.; (and others). Phys. Rev., C; 5: No. 5, 1729-32 (May 1972).

A systematic study of 14 unbound analog states in Tc isotopes was performed via the ^{92,94,96}Mo(^{3}He,d) reactions. Proton form factors were calculated using a simple single-particle resonance model. The proton spectroscopic factors deduced with the distorted-wave Born approximation agree well with the known neutron spectroscopic factors for the parent states obtained from (d,p) reactions. It is concluded that this simple model is adequate for the calculation of spectroscopic factors to unbound analog states in these isotopes. (2 figures, 1 table) (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 33375, 34887, 34905, 34906, 34943, 34960, 34969, and 35006.

34919 (ANL–7848) PHYSICS DIVISION ANNUAL REVIEW, APRIL 1, 1970–MARCH 31, 1971. (Argonne National Lab., Ill.). 1971. 221p. Dep. NTIS.

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34920 (INR–1346) ON THE KNOCK-ON MECHANISM FOR (n,α) REACTIONS ON THE RARE-EARTH NUCLEI ^{160}Dy, ^{162}Dy, AND ^{164}Dy. Kozlowski, Miroslaw; Glowacka, Leopoldyna; Jaskola, Marian; Osakiewicz, Witold; Turkiewicz, Jan; Zemlo, Lucjan (Institute of Nuclear Research, Warsaw (Poland)). 1971. 19p. Dep. NTIS (U. S. Sales Only).

The Feynman-diagram technique has been applied to the neutron-alpha knock-on reactions induced by 14.2 MeV neutrons. For the energy distributions of alpha particles measured in ^{160}Dy(n,α)^{157}Gd, ^{162}Dy(n,α)^{159}Gd and ^{164}Dy(n,α)^{161}Gd reactions a satisfactory description was obtained. (auth)

34921 OBSERVATION OF ANOMALOUS BEHAVIOR OF THE NUCLEAR MOMENT OF INERTIA AT LARGE ROTATIONAL FREQUENCIES IN ^{164}Yb AND ^{168}Hf. Lieder, R. M.; Beuscher, H.; Davidson, W. F.; (and others) (Kernforschungsanlage, Juelich, Ger.). Phys. Lett.; 39B: No. 2, 196-8(17 Apr 1972).

The (α,8n) reaction was used to produce high-spin states in ^{164}Yb and ^{168}Hf. In both cases a sharp increase of the moment of inertia as a function of rotational frequency was observed at I = 12. (auth)

34922 EVIDENCE FOR MIXING OF ROTATIONAL STATES DIFFERING BY ΔK = 2, 3, AND 4. Kemnitz, P.; Funke, L.; Kaun, K.-H.; Sodan, H.; Winter, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Phys. Lett.; 39B: No. 2, 179-81(17 Apr 1972).

In the odd-proton nuclei ^{171}Lu and ^{163}Ho a configuration mixing of close-lying states differing in the K quantum number by 2, 3, or 4 units was found. The mixing can be explained by first-order Coriolis interaction. (auth)

34923 NUCLEAR GROUND STATE SPIN OF ^{167}Lu. Ekstroem, C. (Univ. of Uppsala); Ingelman, S.; Wannberg, B.; Lamm, I.-L. Phys. Lett.; 39B: No. 2, 199-200(17 Apr 1972).

The nuclear ground-state spin of ^{167}Lu($T_{1/2}$ = 53 min) was measured with the atomic-beam magnetic resonance method. The result obtained, I = $\frac{7}{2}$, is in agreement with the value predicted by the Nilsson model. (auth)

34924 DETERMINATION OF THE STATIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ STATES OF THE EVEN–EVEN OSMIUM NUCLEI BY MEANS OF COULOMB EXCITATION. Lane, Stephen Arthur. Pittsburgh; Univ. of Pittsburgh (1971). 82p. University Microfilms Order No. 72-12,777.

Thesis.

Measurements of the total thick-target yields of gamma-rays de-exciting the first 2^+ excited states of ^{192,190,188,186,184}Os following Coulomb excitation by helium, oxygen, and sulfur ions have been made. These measurements were compared with theoretically calculated yields in order to extract the relative static electric quadrupole moments. The relative moments were compared with the measurements of Pryor et al., of the absolute moments of ^{192,190,188}Os in order to obtain the best combined values. The values are −0.50 ± 0.20 (eb), −0.95 ± 0.19 (eb), and −1.32 ± 0.43 (eb) for ^{192}Os, ^{190}Os, and ^{188}Os, respectively. The corresponding values for ^{186}Os and ^{184}Os are −1.47 ± 0.54 (eb) and −2.4 ± 1.1 (eb), respectively. The B(E2, $0^+ \rightarrow 2^+$) values determined in the experiment agree with the published values to within 10%. These results are also compared with the model calculations of Kumar and Baranger and found to be in good agreement. (Diss. Abstr. Int., B)

34925 $K^\pi = 2^-$ OCTUPOLE VIBRATION BAND IN ^{182}W. Herzog, P.; Canty, M. J.; Killig, K. D. (Univ., Bonn). Nucl. Phys.; A187: No. 1, 49-64(1972).

An investigation of the electromagnetic properties of the $K^\pi = 2^-$ octupole band in ^{182}W populated in the β^- decay of ^{182}Ta was undertaken. The multipolarity mixings of the intraband 114 keV and 85 keV transitions were determined from L-subshell measurements. The mixing parameters δ^2(E2/M1) are 0.130(7) and 0.124(2) respectively. The directional correlations of the (1121−100) keV, (1157−100) keV and (1189−100) keV cascades were investigated. The E1, M2, E3 mixing of the 1189 keV transition was extracted from the angular correlation coefficients and conversion data taken from the literature. A mixing of (57.0 ± 3.7)% E1 + (13.7 ± 1.9)% M2 + (29.3 ± 6.6)% E3 was obtained. A centroid shift determination of the lifetime of the 3^-(1374 keV) state gave the result τ = 112 ± 15 ps. From this the reduced E3 transition probability from the ground state was found to be B(E3; $0^+ \rightarrow 3^-$) = (8.0 ± 1.2) · $10^4 e^2 \cdot fm^6$ = (41 ± 6)SPU. The g-factor of this state was measured using the integral PAC method in the hyperfine field of an iron host lattice yielding g = 0.32(9). The experimental data are discussed in terms of the collective model taking into account Coriolis coupling. (auth)

34926 ANALOG STATES IN TANTALUM AND NUCLEAR DEFORMATION BETWEEN THE N = 60 AND N = 126 NEUTRON SHELLS. Seitz, H. (Max Planck Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A186: No. 3, 574-602 (1972).

Analog resonances in ^{178}Hf + p have been measured. Strong resonances are observed in the inelastic channels. The displacement energy has been determined accurately and a shift of the order of 100 keV due to deformation is found. The various contributions to the displacement energy of analog states are summarized and a phenomenological formula is given which describes all accurately known displacement energies between A ≈ 88 and A ≈ 209 within their experimental errors of about 25 keV. The determination of displacement energies constitutes a new method of measuring deformation parameters. Deformation parameters for a number of nuclei are calculated and compared to parameters from other experiments. (auth)

34927 COMPARISON OF IMPACT AND RADIOACTIVITY TECHNIQUES AND THE MAGNETIC DIPOLE MOMENTS OF THE FIRST 2^+ STATES IN ^{188}Os, ^{190}Os, AND ^{192}Os. Sioshansi, R.; Garber, D. A.; King, W. C.; (and others) (Purdue Univ., Lafayette, Ind.). Phys. Lett.; 39B: No. 3, 343-5(1 May 1972).

Comparison of IMPACT, PAC and Mössbauer effect measurements indicate that for g-factor measurements of Os nuclei Ni is a suitable ferromagnetic host whereas the use of Fe in IMPACT measurements may give erroneous results. (auth)

34928 THEORETICAL INVESTIGATION OF THE MUONIC AND MOESSBAUER ISOMER SHIFTS IN ^{153}Eu. Meyer, J.; Speth, J. (Technische Univ., Garching, Ger.). Phys. Lett.; 39B: No. 3, 330-4(1 May 1972).

The muonic isomer shift and the change of the mean square charge radius of the $\frac{5}{2}-$ [532] and $\frac{3}{2}+$ [411] level in ^{153}Eu are calculated simultaneously using the theory of finite Fermi systems. The results are compared with recent experimental data; the difference of the electron density at the nucleus in Eu^{2+}—and Eu^{3+}—compounds is deduced from the analysis. (auth)

34929 EXCITED LEVELS OF ^{155}Tb OBTAINED IN THE RADIOACTIVE DECAY OF ^{155}Dy. Barat, J. L.; Treherne, J. (Univ., Grenoble, France). Compt. Rend., Ser. B; 274: No. 6, 427-8(7 Feb 1972). (In French).

Excited levels of ^{155}Tb were established from measurements of the relative intensities of internal conversion electron lines, γ ray lines, and $\gamma\gamma$ coincident measurements. (France)

34930 TOTAL CROSS SECTIONS OF HAFNIUM AND HAFNIUM HYDRIDE. Brand, K. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Geesthacht, Ger.); Saad, M. Atomkernenergie; 19: No. 3, 262(May 1972).

The total neutron cross sections for powder samples Hf and $HfH_{1.99}$ have been measured with a crystal spectrometer. The energy range was 0.073 to 0.727 eV, the resolution between 1 and 4% and the sample at room temperature. (auth)

34931 DIRECT DETECTION OF THE K-SHELL PERTURBATION CAUSED BY THE STATIC NUCLEAR QUADRUPOLE MOMENT. Sen, S. K. (Univ. of Manitoba, Winnipeg); Salie, D. L.; Tomchuk, E. Phys. Rev. Lett.; 28: No. 20, 1295-8(15 May 1972).

It was found that K x rays accompanying K conversion of retarded 177-keV (predominantly M1) transitions from the 316-keV ($T_{1/2}$ = 0.66 μsec) nuclear state of highly deformed ^{169}Tm have small anisotropic angular distributions with respect to the direction of γ radiations emitted subsequent to K conversion. The result is explained as a first-order effect of the static quadrupole moment of the nucleus on the K-shell electron wave function. (auth)

34932 USE OF THE ANGULAR MOMENTUM PROJECTION TECHNIQUE IN TWO-NUCLEON TRANSFER REACTIONS ON DEFORMED NUCLEI. Kammuri, T. (Univ. of Copenhagen); Kusuno, S.; Yamaji, S. Phys. Lett.; 39B: No. 3, 327-9(1 May 1972).

The spectroscopic amplitudes for the two-nucleon transfer reactions on the deformed nuclei are calculated by using angular momentum eigenstates projected from the superconducting intrinsic state. For the case of the ^{154}Sm(p,t)^{152}Sm reaction, the effects of the angular momentum projection are small for the cross sections leading to the 0^+, 2^+, and 6^+ members of the ground-state rotational band, while the effect is quite large for the 4^+ transition. (auth)

34933 EXCITATION OF NUCLEAR COLLECTIVE STATES BY RADIATIONLESS MUONIC TRANSITIONS. Kanatas, George. Lawrence, Kan.; Univ. of Kansas (1971). 93p. University Microfilms Order No. 72-11,758.

Thesis.

An investigation is made of selected even-even nuclei in the rare-earth and actinide regions for possible resonances between pairs of muonic levels of the appropriate quantum numbers and certain collective states. Such resonances can lead to the excitation of the particular nuclear state involved, and could be used as an alternate means of nuclear excitation. Electric monopole excitations were found which can result in the excitation of the nuclear 0^+ level of the beta band. Dipole and octupole excitations of the nuclear octupole band as well as quadrupole excitation of the gamma band were investigated. The muonic states involved, however, are such that the probability of nuclear excitation may be very small, in all these possibilities. An electric quadrupole resonance in ^{182}W involving the 2^+ state of the beta band, however, was found to be a very likely candidate. The matrix elements involved in these resonance possibilities are calculated. The eigenvalues and eigenfunctions of the muon were obtained by solving the Dirac equation numerically for a spherical potential, including vacuum polarization corrections. A muonic cascade calculation is done for ^{182}W in order to calculate the relative population of the muonic levels and to determine the probability of nuclear excitation for the above E2 resonance. (Diss. Abstr. Int., B)

34934 PARITY-VIOLATING AND NORMAL MULTIPOLE MIXING RATIOS OF THE 57-keV GAMMA TRANSITION OF ^{180}Hf. Krane, K. S.; Olsen, C. E.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 5: No. 5, 1663-7(May 1972).

The parity-violating forward—backward asymmetry of the 57-keV γ radiation from low-temperature polarized ^{180m}Hf was measured to be $-(19.4 \pm 9.2) \times 10^{-4}$, this result indicating the lack of any large parity-violating effect for this very strongly hindered E1 transition, in agreement with calculations. The M2/E1 and E3/E1 multipole mixing ratios of the 57-keV transition were determined to be δ_1(M2/E1) = $-(0.009^{+0.065}_{-0.085}$ and δ_2(E3/E1) = $+0.013 \pm 0.020$. (3 figures, 1 table) (auth)

34935 ISOMER SHIFT STUDIES OF GADOLINIUM AND YTTERBIUM ISOTOPES. Russell, Philip Boyd. Stanford, Calif.; Stanford Univ. (1971). 159p. University Microfilms Order No. 72-11,652.

Thesis.

Isomer shift studies of the even-even rotational nuclei ^{158}Gd, ^{160}Gd, ^{170}Yb, ^{172}Yb, ^{174}Yb, and ^{176}Yb have been conducted by means of the Mössbauer effect. In the case of ^{170}Yb a source of resonant gamma rays was obtained in the conventional manner by using a radioactive source to populate the first excited state of the nucleus. For the other nuclei the Mössbauer source was created by the method of recoil implantation through vacuum following Coulomb excitation. In this manner a beam of high energy ions (64-MeV ^{35}Cl ions in this study) is used to Coulomb excite the nuclei of interest in a thin foil target and to cause the excited ions to recoil out of the target, through a vacuum, and into a separate medium. After stopping in the medium the excited nuclei decay and, if other conditions are favorable, provide a source of resonant gamma rays for a Mössbauer effect experiment. This latter method of producing a Mössbauer source is especially appropriate for the study of the neutron-rich nuclei ^{158}Gd, ^{160}Gd, and ^{176}Yb, since these nuclei do not have radioactive parents of sufficiently long half-life for use in a conventional source experiment. The measured isomer shifts were used to extract ratios of $\Delta\langle r^2\rangle$, the change in the mean squared nuclear charge radius accompanying excitation of the first excited state. In the case of the ytterbium isotopes, the effect of interference between resonant nuclear absorption and atomic photoelectric absorption was observed and found to affect isomer shifts measured with respect to the Mössbauer source. However, relative isomer shifts between different absorbers were only slightly altered by this effect, so that values of $\Delta\langle r^2\rangle$ were not significantly influenced. Values obtained for the ratio of $\Delta\langle r^2\rangle$ between different isotopes were, for gadolinium, $\Delta\langle r^2\rangle_{158}/\Delta\langle r^2\rangle_{156} = 0.5 \pm 0.3$, $\Delta\langle r^2\rangle_{160}/\Delta\langle r^2\rangle_{156} = 0.1 \pm 0.3$, and for ytterbium, $\Delta\langle r^2\rangle_{172}/\Delta\langle r^2\rangle_{170} = 0.34 \pm 0.07$, $\Delta\langle r^2\rangle_{174}/\Delta\langle r^2\rangle_{170} = +0.36 \pm 0.07$, $\Delta\langle r^2\rangle_{176}/\Delta\langle r^2\rangle_{170} = -0.13 \pm 0.04$. Previous experimental results for ^{158}Gd and ^{172}Yb are in agreement with the present results, but a published experimental ratio for ^{174}Yb is in disagreement with that given above. The present results indicate a marked dependence of nuclear rigidity upon the neutron member of a given isotope, even in the case of the ytterbium isotopes where the nuclear deformation is essentially constant among all even-even isotopes. The observed ratios of $\Delta\langle r^2\rangle$ are discussed in terms of their implications for nonadiabatic changes in intrinsic nuclear structure induced by rotational excitation. In particular, the experimental results are compared with predictions of the self-consistent microscopic model of Marshalek. In addition, the possible effects of radiation damage in the implanted sources are explored. (Diss. Abstr. Int., B)

34936 SPIN AND PARITY ASSIGNMENTS AND LEVELS IN ^{156}Gd POPULATED BY THE DECAY OF ^{156}Tb. Hamilton, J. H. (Vanderbilt Univ., Nashville); Fujioka, M.; Pinajian, J. J.; McMillan, D. J. Phys. Rev., C; 5: No. 5, 1800-6(May 1972).

Accurate conversion-electron and γ-ray intensities were combined to obtain K-conversion coefficients for 80 transitions in ^{156}Gd from the decay of 5.4-day ^{156}Tb. These data were used to make spin and parity assignments for the following levels: 1538.90, (3)$^-$; 1851.84, 3$^-$; 1948.98, 3$^-$; 1952.32, 4$^-$; 2175.08, 3$^-$, 4$^-$; and 2232.52 keV, 3$^-$, 4$^-$. Levels at 1462.26, 1506.89, and 1538.90 keV are now established on the basis of coincidence data. A complete level scheme is presented that incorporates all of the different features seen in recent studies. (2 figures, 3 tables) (auth)

34937 ^{175}Lu(n,γ) REACTION AND LEVEL STRUCTURE OF ^{176}Lu. Fubini, A.; Prosperi, D.; Terrasi, F.; Vata, I. (CNEN, Rome). Nuovo Cim.; 8A: No. 4, 748-58(21 Apr 1972).

The ^{176}Lu level scheme was investigated by means of the ^{175}Lu(n_{th},γ) reaction. The 2 to 6 MeV γ-ray spectrum was measured with a Ge(Li) spectrometer and a level scheme was constructed by means of the Ritz combination method. Some rotational bands not previously observed were identified. The intrinsic configuration of each one is discussed on the basis of the known levels of neighboring nuclei. (auth)

Nuclear Properties and Reactions, $190 \leq A \leq 219$

Refer also to abstracts 34851, 34889, 34924, 34927, 34960, 34966, and 35042.

34938 (ORNL-4765) AN EVALUATION OF NEUTRON AND GAMMA-RAY-PRODUCTION CROSS SECTIONS FOR LEAD. Fu, C. Y.; Perey, F. G. (Oak Ridge National Lab., Tenn.). 17 Mar 1972. Contract W-7405-eng-26. 106p. Dep. NTIS.

A survey was made of the available information on neutron and gamma-ray-production cross section measurements of lead. Evaluated nuclear data sets in the ENDF/B format were prepared for lead covering the energy range from 0.00001 eV to 20.0 MeV. The cross section sets were based on experimental results available to June 1971 and on nuclear model calculations. This evaluation received MAT. No. 4136 in the DNA Library and 1136 for CSEWG. (auth)

34939 EVIDENCE FOR ENERGY DEPENDENCE IN THE ISOSPIN DEPENDENT PART OF THE NUCLEAR OPTICAL MODEL POTENTIAL. Woods, T. J.; Igo, G. J.; Whitten, C. A. Jr. (Univ. of California, Los Angeles). Phys. Lett.; 39B: No. 2, 193-5(17 Apr 1972).

Angular distributions and the excitation function of the cross section for the ^{208}Pb(p,n) charge exchange reaction are fitted with DWBA calculations. Isospin potentials which have the relative real volume and surface imaginary strengths found in the optical-model studies of Becchetti and Greenlees provide adequate fits to the angular distributions. The excitation function indicates a strong energy dependence in the strength of the isospin potential. (auth)

34940 DEUTERON BREAKUP IN THE FIELD OF A HEAVY NUCLEUS, Au(d,np)Au. Jarczyk, L.; Lang, J.; Mueller, R.; (and others) (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 39B: No. 2, 191-2(17 Apr 1972).

The breakup of deuterons in the field of a gold nucleus was measured at a deuteron energy of 12 MeV. The energy—angle correlations are compared with two different theoretical models which take into consideration only the Coulomb interaction. (auth)

34941 ELECTRIC SCATTERING OF 30 TO 90 MeV ELECTRONS FROM $^{206\ 207\ 208}$Pb. De Jager, C. W.; Maas, R.; De Vries, C. (Instituut voor Kernphysich Onderzoek, Amsterdam). Phys. Lett.; 39B: No. 2, 188-90(17 Apr 1972).

The elastic electron scattering cross sections for ^{206,207,208}Pb were measured for momentum transfers between 0.2 and 0.9 fm^{-1}. The extracted differences in the charge distribution parameters are compared with recent atomic and muonic x-ray results. (auth)

34942 COULOMB DISINTEGRATION OF ^{6}Li. El-Nadi, M.; Osman, A. (Cairo Univ.). Phys. Lett.; 39B: No. 2, 156-8 (17 Apr 1972).

The Coulomb disintegration of ^{6}Li in the strong Coulomb field of a heavy target nucleus into alpha and deuteron particles is studied. The total cross section is calculated as a function of the cluster overlap parameter and of the ^{6}Li incident energy. Satisfactory results are obtained. (auth)

34943 ISOTOPIC SPIN CONSERVATION FOR LOW LYING COLLECTIVE STATES OF HEAVY NUCLEI. Nersesov, E. A. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 15: No. 2, 213-19(Feb 1972). (In Russian).

On the basis of a theory of finite Fermi systems an expression is obtained for the matrix element of a Fermi-type β^- transition from the ground state of a 0$^+$ odd—odd deformable nucleus to a β-vibrational level of the corresponding even—even nucleus. (auth)

34944 EXCITATION OF 3-min ACTIVITY IN ^{190}Re USING ^{190}Os (n,p) REACTION WITH 14.8-MeV NEUTRONS. Rurarz, E. (Inst. of Nuclear Research, Swierk, Poland); Myslek, B.; Oblozinsky, P. Acta Phys. Pol., B3: No. 2, 195-7(Mar-Apr 1972).

The cross-section for excitation of the 3 min ground state of ^{190}Re in (n,p) reaction on natural osmium is determined as (1.9 ± 0.3) mb at 14.8 MeV neutron energy. (auth)

34945 INFORMATION ON LEVEL DENSITIES OF NEAR DOUBLY MAGIC NUCLEI FROM (p,α) REACTIONS. Gadioli, E.; Iori, I.; Molho, N.; Zetta, L. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Lett. Nuovo Cim.; 3: No. 17, 677-83(22 Apr 1972).

Alpha spectra and differential cross sections for the ^{208}Pb and ^{209}Bi(p,α) reactions were measured for proton energies from 30 to 45 MeV. The results were used along with previously-known compound nucleus cross sections to obtain information on the high-energy behavior of level densities of near doubly-magic nuclei. Revised level density parameters for near doubly-magic nuclei are suggested. (J.W.R.)

34946 ELECTROMAGNETIC PROPERTIES OF THE TRANSITIONAL ODD-A NUCLEI STUDIED BY PROJECTION METHOD. Feifrlik, V. (Nuclear Research Inst., Rez, Czech.). Nucl. Phys.; A186: No. 3, 665-72(1972).

In the framework of the angular momentum projection method, the amplitudes of quadrupole electric transitions and the quadrupole moments of odd-A nuclei are calculated. A microscopic method is presented to evaluate these quantities. The method is applied to ^{193}Ir and ^{195,197}Au. (auth)

34947 COUPLING EFFECTS IN ^{208}Pb. Ascuitto, R. J. (Yale Univ., New Haven); Soerensen, Bent. Nucl. Phys.; A186: No. 3, 641-64(1972).

A re-evaluation of the renormalization concept for the treatment of anharmonic couplings between elementary degrees of freedom leads to the understanding of a number of states in ^{208}Pb, their excitation energies as well as their population in ^{206}Pb(t,p) and ^{210}Pb(p,t) reactions, which are both analyzed and compared with experiments. (auth)

34948 DECAY SCHEME FOR THE ^{209}At NUCLEUS, HAVING A HALFLIFE OF 5.3 HOURS. Charvet, Andre; Chery, Roland; Do Huu Phuoc; (and others) (Univ., Lyon). Compt. Rend., Ser. B; 274: No. 4, 290-3(24 Jan 1972). (In French).

The 5.3 hour electron capture decay of ^{209}At into ^{209}Po was studied using Ge(Li) and Si(Li) detectors to observe the direct γ and e_c^- spectra, and the γ—γ coincidences. The results obtained enable 35 out of the 40γ ray lines observed to be classified. The nature of the excited states is discussed in terms of the shell model. (France)

34949 EXCITED LEVELS IN ^{190}Hg AND A 24.5-ns ISOMER. Inamura, Takashi; Tendow, Yoshihiko; Nagamiya, Shoji; Hashizume, Akira (Inst. of Physical and Chemical Research, Wako, Japan). J. Phys. Soc. Jap.; 32: No. 5, 1163-8(May 1972).

Time distributions of γ-rays from the ^{181}Ta(^{14}N,5n)^{190}Hg reaction were observed between natural beam bunches of a cyclotron. Excitation functions and anisotropies of γ-rays were also measured. The 418 keV ($2^+ \rightarrow 0^+$), 626 keV ($4^+ \rightarrow 2^+$), and 723 keV ($6^+ \rightarrow 4^+$) γ-rays from ^{190}Hg have been found to decay with a half-life, $T_{1/2}$ = 24.5 ± 0.7 ns. A new level scheme of ^{190}Hg is proposed; the 8$^+$, 7$^-$, and 5$^-$ levels are placed at 2468, 2016, and 1828 keV, respectively, and the 24.5 ns isomer is assigned to a 10$^+$ state tentatively placed at 2604 keV. (auth)

34950 PROPERTIES OF LEVELS IN ^{198}Pb AND ^{200}Pb. Krien, K.; Spejewski, E. H.; Naumann, R. A.; Huebel, H. (Princeton Univ., N. J.). Phys. Rev., C; 5: No. 5, 1751-9(May 1972).

The decay of ^{198}Bi and ^{200}Bi to levels in the corresponding Pb daughters was investigated using sources which were both mass-separated and chemically processed. γ-ray and conversion-electron singles spectra were obtained, as well as γ—γ prompt- and delayed-coincidence spectra. These data yield levels in ^{198}Pb at the following energies (spin—parities): 1062.9 (2$^+$), 1624.9 (4$^+$), 1822.3 [(5)$^-$], and 2139.8 [(7)$^-$] keV. Those in ^{200}Pb are at 1026.3 (2$^+$), 1488.3 (4$^+$), 1907.8 [(5)$^-$], and 2152.9 [(7)$^-$] keV. The half-life of the 1822-keV level in ^{198}Pb was determined to be 63.3 ± 2.5 ns; the half-lives of the 1908- and 2153-keV levels in ^{200}Pb are 1.50 ± 0.08 and 47.6 ± 2.5 ns, respectively. (11 figures, 3 tables) (auth)

34951 NUCLEAR MATRIX ELEMENTS IN THE FIRST-FORBIDDEN BETA DECAY OF ^{203}Hg. Smith, Hastings A. Jr. (Los

Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 5: No. 5, 1732-7(May 1972).

Nuclear matrix elements in the $5/2^-$(210-keV β) $3/2^+$(279-keV γ) $1/2^+$ $\beta-\gamma$ cascade in ^{203}Hg were extracted, and comparison was made with conserved-vector-current (CVC) theory predictions for the vector-matrix-element ratio $\int\vec{\alpha}/(\int i\vec{r}/R)$. This ratio was found to be significantly smaller than the CVC prediction based on the assumption that the Coulomb Hamiltonian is diagonal. Reasonably good limits were placed on the matrix elements in spite of the fact that the Coulomb-enhanced matrix element combination tends to dominate the transition. The nuclear matrix elements do not support a strict single-particle picture of this β decay; this result is in agreement with the current knowledge of the structure of the initial and final states. (4 figures, 4 tables) (auth)

34952 DEUTERON-INDUCED REACTIONS ON THE EVEN–EVEN ISOTOPES OF MERCURY. Moyer, R. A. (Univ. of Pittsburgh). Phys. Rev., C; 5: No. 5, 1678-1705(May 1972).

Over 300 transitions up to 4.5 MeV in excitation energy were observed in the (d,t) and (d,p) reactions on ^{204}Hg, ^{202}Hg, ^{200}Hg, and ^{198}Hg and in the (d,d′) reaction on ^{204}Hg, ^{202}Hg, and ^{201}Hg at a bombarding energy of 17 MeV. All targets were isotopically enriched, and outgoing particles were detected in a split-pole spectrograph having 8- to 14-keV (full width at half maximum) resolution. Over 100 angular distributions in the (d,p) and (d,t) reactions were measured and compared with distorted-wave Born-approximation calculations to assign l values and extract spectroscopic factors. Two new very low-lying levels were identified—a $p_{1/2}$ at ~0.005 MeV in ^{203}Hg and a $f_{5/2}$ at ~0.028 MeV in ^{201}Hg. The (d,t) reaction excited only shell-model neutron-hole levels, while the (d,p) reaction excited shell-model neutron-particle levels above the N = 126 gap with greatest intensity in the heavier mercury isotopes. In the lighter mercury isotopes, the (d,p) reaction increasingly excited the neutron-hole states until in ^{199}Hg the neutron-hole states are excited with greatest intensity. Fragmentation of all the single-particle and single-hole levels is seen and tends to increase in the lighter mercury isotopes. (12 figures, 9 tables) (auth)

34953 ANTIANALOG STATES IN ^{209}Bi. Beres, W. P.; Voges, D. A. (Wayne State Univ., Detroit). Lett. Nuovo Cim.; 3: No. 16, 653-6(15 Apr 1972).

The properties of the antianalog states in ^{209}Bi were investigated. The Coulomb matrix elements between antianalog states and the corresponding analog resonances of the same spin and parity were calculated. The resulting contribution to the compound spreading widths of the analog resonances was then determined. (J.W.R.)

34954 IMPLICATIONS OF THE ALLOWED UNHINDERED β^- DECAY OF 3 min ^{190}Re. Daly, P. J.; Yates, S. W.; Cunnane, J. (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; A187: No. 2, 446-8(1972).

It is argued that the fast β^- decay of ^{190}Re involves the allowed unhindered transition $9/2^-[505]\nu - 5/2^+[402]\pi\ JK^\pi = 22^- \rightarrow 11/2^-[505]\pi - 5/2^+[402]\pi\ JK^\pi = 33^-$ in accord with a recent microscopic description of $K^\pi = 3^-$ octupole excitations in the osmium region. (auth)

Nuclear Properties and Reactions, $A \geq 220$

Refer also to abstracts 33185, 33232, 33462, 34943, 35010, and 35241.

34955 (BMBW-FBK-71-17, pp 1.1-30) SOME ATOMIC AND NUCLEAR PROPERTIES OF PROTACTINIUM. Cauchois, Y. (Paris Univ. (France). Laboratoire de Chimie Physique). Oct 1971. (In French).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

In the forefront of the atomic properties of an element are the electronic configurations of the atoms and the corresponding ions. Indeed, they determine the chemical and physical properties of the element and whether it will be experimentally accessible. The energies of various configurations as calculated by different methods are tabulated, and optical spectra are discussed. If agreement between experimental and theoretical results can be obtained, predictions may be possible for the properties of an element (homologous to Pa) at the start of a "superlanthanide" series. A summary of information on the different isotopes of Pa is given including data on decay modes, half-lives, levels, and spin–parity assignments. (6 figures, 6 tables) (R.W.R.)

34956 (BMBW-FBK-71-17, pp 2.1-11) HEAVY ISOTOPES OF PROTACTINIUM: FORMATION, ISOLATION, MASS ASSIGNMENT AND CROSS SECTIONS. Denig, R.; Trautmann, N.; Kaffrell, N.; Herrmann, G. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

A modified solvent extraction, where the extractant is absorbed on the surface of a chemically very resistant material, was found for fast, clean isolation of Pa. The solvent was diisobutylcarbinol; and the plastic material, poly(trifluoromonochloroethylene). Greater than 99% extraction was obtained is 5 sec/ml; however, this separation procedure cannot be used generally, especially if heavy Pa isotopes must be isolated from targets. Heavy Pa isotopes can be produced by neutron and photon bombardment of U targets. Because the fission competition is so great, however, a six-step separation procedure was devised. Counting can be done about 2.5 min after bombardment. Half-lives and relative beta activities of ^{235,236,237,238}Pa are tabulated, as well as the cross sections for the ^{238}U(n,p), ^{238}U(n,pn), ^{238}U(n,α), ^{238}U(n,t), and ^{235}U-(n,p) reactions at 14 MeV. The half-life of ^{235}Th was determined to be 6.9 ± 0.2 min, while that of ^{234m}Pa was 70.5 sec. (7 figures) (R.W.R.)

34957 (BMBW-FBK-71-17, pp 3.1-16) HEAVY ISOTOPES OF PROTACTINIUM: DECAY OF 9.1-MIN ^{236}Pa AND 8.7-MIN ^{237}Pa. Trautmann, N.; Kaffrell, N.; Denig, R.; Herrmann, G. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

^{236}Pa was produced either by irradiating ^{236}U with 14-MeV neutrons or by a (γ,pn) reaction with ^{238}U. The half-life was 9.1 ± 0.2 min, and the maximum β energy was 3.2 ± 0.2 MeV. The γ spectrum was obtained and the decay scheme was partially established. For ^{237}Pa, the half-life was 8.7 ± 0.2 min, and the maximum β energy was 2.3 ± 0.2 MeV. The γ spectrum showed 16 peaks with the strongest situated at 529, 853, and 865 keV. The decay scheme for ^{237}Pa was established. (9 figures) (H.B.G.)

34958 (BMBW-FBK-71-17, pp 4.1-13) HEAVY ISOTOPES OF PROTACTINIUM: DECAY OF 24-MIN ^{235}Pa AND 2.3-MIN ^{238}Pa. Kaffrell, N.; Trautmann, N.; Denig, R.; Herrmann, G. (Mainz Univ. (West Germany). Institut fuer Anorganische Chemie und Kernchemie). Oct 1971. (In German).

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

^{235}Pa was obtained through the processes ^{235}U(n,p) and ^{236}U(γ,p). The half-life of 24.2 ± 0.3 min as well as the maximum β energy of 1.4 MeV agreed with those reported by other workers. ^{238}Pa was produced through 14-MeV neutron irradiation of ^{238}U. The half-life was 2.3 ± 0.1 min, and the maximum β energy was 2.9 MeV. The γ spectrum showed strong peaks at 448, 517, 583, 635, 680, 687, 805, 864, 885, 1015, 1060, and 1084 keV. The decay scheme was established. (8 figures) (H.B.G.)

34959 (BMBW-FBK-71-17, pp 5.1-15) DETERMINATION OF THE RESONANCE INTEGRAL AND THE EFFECTIVE CROSS SECTION OF ^{231}Pa. Flakus, F. N.; Kim, J. I.; Kemmer, J. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). Oct 1971.

From third international protactinium conference; Schloss Elmau, Germany (15 Apr 1969).

The resonance integral and the effective cross section for the ^{231}Pa(n,γ)^{232}Pa reaction were determined with the use of a Cd shield and gold as a standard monitor. The results are compared with the calculated values in the literature. (7 figures, 2 tables) (auth)

34960 (BNL–16705) STRUCTURE OF NEUTRON RESONANCES. Chrien, R. E. (Brookhaven National Lab., Upton, N. Y.). [1972]. 42p. Dep. NTIS.

Certain topics relevant to the structure of neutron resonances are discussed. A summary of experimental techniques for resonance studies via the (n,γ) reaction and the inverse (γ,n) reaction is given. Experiments relating to direct reaction mechanisms, partial width correlations, pygmy resonances, and doorway states are described. (30 figures, 4 tables) (auth)

34961 (FEI–259) RE-EVALUATION OF CROSS SECTIONS FOR THE RADIATIVE CAPTURE OF FAST NEUTRONS BY ^{238}U. Abramov, A. I.; Tolstikov, V. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

A survey of the literature to December, 1970 on neutron radiative capture cross sections of ^{238}U was made. A smoothing table was compiled giving values of σ_γ for ^{238}U for neutron energies from 1.01

to 1000 keV. The corresponding range of cross sections runs from 2,980 to 3.35 mbarns. (51 references) (K.S.W.)

34962 (IAE–2069) ^{235}U FISSION BY SLOW NEUTRONS. Zakharova, V. P. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

The distribution of the total kinetic energy of fragment pairs from the fission of ^{235}U by slow neutrons was investigated as a function of the ratio of their masses. A double ionization chamber and associated circuitry served to record the fragment energy. The symmetric and strongly asymmetric regions of the energy spectrum were in sharp contrast to the intermediate region; the former lost the single-humped Gaussian distribution. Reasons for this behavior are advanced. (12 figures) (tr-auth)

34963 (IEA–254) SLOW-NEUTRON CROSS-SECTION FOR URANIUM OXIDE. Rodrigues, C.; Vinhas, L. A.; Herdade, S. B.; Amaral, L. Q. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Nov 1971. 11p. Dep. NTIS (U. S. Sales Only).

The total cross section of a polycrystalline sample of uranium oxide has been measured in the energy range from 0.08 eV to 0.0013 eV, using the slow-neutron chopper and time-of-flight spectrometer at the IEAR-1 reactor. The absorption cross section was determined subtracting the calculated scattering cross section affected by the experimental resolution from the measured total cross section. The obtained absorption cross section values are compared with the calculated curve on basis of the single level Breit–Wigner formula. A reasonable agreement between the experimental points and the theoretical curve is observed. (auth)

34964 (JINR–P6-6288) NEW ISOTOPE ^{189}Tl. Vandlik, T. B.; Vandlik, Ya.; Zaitseva, N. G.; Mate, Z.; Makhunka, I.; Makhunka, M.; Fenesh, T.; Tyrroff, Kh.; Yakhim, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

Three gamma-lines (E_γ = 216.3; 229.0; 335 keV) were observed in the decay of the new isotope ^{189}Tl. Its half-life was found to be: $T_{1/2} = 1.4 \pm 0.4$ min. Sources of ^{189}Tl were produced by mass-separating of the thallium fraction, extracted from a PbF_2 target ("on-line" chemistry) irradiated with 660-MeV protons. For the measurement of gamma-ray spectra a Ge(Li) detector was used. (auth)

34965 (LIB/Trans–380) RADIATIVE CAPTURE OF NEUTRONS BY THE ^{232}Th NUCLEUS IN THE ENERGY RANGE 0.01 TO 15 MeV. Davletshin, A. N.; Tolstikov, V. A.; Abramov, A. I. Translated by W. Plotnikoff (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report FEI–234. 33p. Dep. NTIS (U. S. Sales Only).

In this work a critical examination of the experimental measurements of $\sigma(n,\gamma)^{232}$Th for neutrons with energies above 10 keV is made. In a number of cases the results of the measurements have been renormalized to values of the cross sections which are currently accepted as reference. A procedure for averaging cross sections is proposed which takes into account the form of the dependence of the cross section on energy. Based on the analysis of data from several authors, a recommended curve is given for the dependence of $\sigma(n,\gamma)^{232}$Th on neutron energies in the interval 0.01–14.5 MeV. The numerical data used for renormalization and averaging is quoted in full. Also quoted is the recommended value of the radiative capture cross section of ^{232}Th for thermal neutrons. (auth) (Australia)

34966 (NCSAC–42) REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY COMMITTEE MEETING AT BROOKHAVEN NATIONAL LABORATORY, NEW YORK, NOVEMBER 17–19, 1971. Jackson, H. E. (comp.) (Argonne National Lab., Ill.). 280p. (EANDC(US)–165(U); INDC(USA)–36(U); CONF-711137). Dep. NTIS.

This material is of the nature of informal statements of recent developments and preliminary data. The following subjects are included: microscopic neutron cross sections relevant to the nuclear energy program, including pertinent inverse reactions; charged-particle cross sections relevant to the nuclear energy program or to development and testing of nuclear models; gamma production, radioactive decay, and theoretical developments in nuclear structure applicable to nuclear energy programs; and proton and alpha cross sections up to 1 GeV of interest to the space program. (R.W.R.)

34967 (NEDO–12154) COMPILATION OF FISSION PRODUCT YIELDS, VALLECITOS NUCLEAR CENTER, 1972. Meek, M. E.; Rider, B. F. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Jan 1972. 131p. (71-NED-41).

A compilation of 6300 fission yield measurements reported in the open literature and calculated charge distributions have been utilized to produce a recommended set of yields for the known fission products. The original data with reference sources as well as the recommended yields are presented in tabular form for the fissionable nuclides U-235, Pu-239, Pu-241, and U-233 at thermal neutron energies; for U-235, U-238, Pu-239, and Th-232 at fission spectrum energies; and U-235 and U-238 at 14 MeV. (auth)

34968 QUESTION OF THE MASS DISTRIBUTION OF THE LRP-FISSION PRODUCTS. Bogdanov, V. G.; Solov'eva, Z. I.; Shigaev, O. E.; Bychenkov, V. S. Yadern. Fiz.; 15: No. 2, 209-12(Feb 1972). (In Russian).

The values of a coefficient k which takes into account the α-particle recoil effect at the construction with $E_l m_l = kE_h m_h$ formula of the LRP-fission mass distribution is calculated for different fragment mass ratios of the ^{235}U LRP-fission by thermal neutrons and of the ^{238}U by fast neutrons. (3 figures, 1 table) (auth)

34969 SECONDARY EFFECTS PRODUCED BY INTERACTION OF 28 GeV PROTONS WITH HEAVY-ELEMENT TARGETS. Chu, Y. Y.; Franz, E. M.; Friedlander, G. (Brookhaven National Lab., Upton, N. Y.). Nucl. Phys.; B40: 428-36(1972).

Contributions to the production of ^{24}Na in Al beam monitors due to secondary particles from the interaction of 28-GeV protons with uranium, thorium, and tantalum targets were measured. Per 100 mg/cm^2 of target thickness they were found to be 13% for U and Th, 7.8% for Ta. The contributions to the production of neutron-excess nuclides in the fission region by secondary particles in the irradiation of uranium targets by 28-GeV protons were determined by comparison with the yields of neutron-deficient species in targets of three different thicknesses and linear extrapolation to zero thickness. These secondary contributions were found to depend on the mass of the product nuclides. The production cross sections for ^{83,91,92}Sr, ^{100,109}Pd, ^{128,140}Ba, ^{140,147}Nd, and ^{145,153}Sm in the interaction of 28-GeV protons with uranium were measured. (auth)

34970 PREDICTIONS FOR SUPERHEAVY NUCLEI. Nix, James Rayford (Los Alamos Scientific Lab., N. Mex.). Phys. Today; 25: No. 4, 30-8(Apr 1972).

Reasons for expecting stability in superheavy nuclei are discussed qualitatively, and a method for calculating it is given. Methods of producing these nuclei and the associated problems are explained. Partial half-lives and other properties of superheavy nuclei are presented. (7 figures, 3 tables) (R.W.R.)

34971 RADIOCHEMICAL STUDY OF ^{238}U AND ^{232}Th FISSION INDUCED BY NEUTRONS OF 2.95 AND 14.8 MeV. Swindle, Dale Lloyd Jr. Fayetteville, Ark.; Univ. of Arkansas (1972). 80p. University Microfilms Order No. 72-10,193.
Thesis.

New radiochemical procedures were developed to attain rapid separation of arsenic and germanium activities from mixed fission products. The basis of decontamination was extraction of As^{+3} and Ge^{+4} into CCl_4 from ≥10N HCl solutions. Further purification was achieved by back-extraction into water and precipitating Ge as Ge–tannate or reduction of As to the metal. Decontamination factors of 3×10^7 and chemical yields of about 30% were determined for the arsenic and germanium fractions in this investigation. The fission yields of ^{238}U and ^{232}Th in the low-mass region were radiochemically determined for 5 mass chains: A = 73, 77, 78, 79, and 81. The absolute activities of these nuclides were determined by gross beta counting. The cumulative fission yields were measured to be: for ^{238}U, 0.0053 ± 0.001, 0.030 ± 0.005, 0.040 ± 0.005, 0.18 ± 0.03 and 0.33 ± 0.05, and for ^{232}Th, 0.008 ± 0.002, 0.10 ± 0.02, 0.21 ± 0.04, 0.95 ± 0.15 and 1.21 ± 0.20%, respectively. A comparison of these yields was made with corresponding mirror points, assuming 3.5 and 4.5 secondary neutrons emitted per fission of ^{238}U and ^{232}Th respectively. The data were also plotted with previously reported fission yields (from this lab as well as others) to better define the mass distribution for ^{238}U and ^{232}Th in 14.8 MeV neutron induced fission. The 3 MeV neutron induced fission yields of ^{232}Th in the mass regions of A = 77–93 and A = 141–156 were radiochemically determined by isolating fission products belonging to 15 mass chains: 77, 78, 79, 81, 91, 93, 99, 141, 143, 145, 147, 149, 151, 153 and 156. The absolute activities of these nuclides were calculated by absolute β^- and γ-counting and the cumulative fission yields were calculated relative to ^{99}Mo. The cumulative fission yields were measured to be 0.10 ± 0.005, 0.036 ± 0.004, 0.075 ± 0.008, 0.50 ± 0.05, 6.9 ± 0.7, 7.35 ± 0.07, 3.00 ± 0.05, 6.6 ± 0.7, 6.0 ± 0.6, 4.7 ± 0.5, 2.2 ± 0.2, 1.0 ± 0.1, 0.10 ± 0.02, 0.030 ± 0.004 and 0.0013 ± 0.0005%, respectively. These data were used to define the extreme wings of the mass yield curve for ^{232}Th. By comparison of complementary fission fragments it was determined that 2.4 secondary neutrons are emitted per fission of ^{232}Th at 3 MeV. A qualitative comparison is made concerning the general features of the ^{232}Th mass yield curves at 14.8 MeV and 3 MeV neutron induced fission. (Diss. Abstr. Int., B)

34972 CUMULATIVE YIELDS OF 40.1 MIN ^{123}Sn, 9.6 MIN ^{125}Sn. AND ^{128}Sn FROM THERMAL-NEUTRON INDUCED FISSION OF ^{235}U. Lin, Chien-chang; Wahl, Arthur C. (Washington Univ., St. Louis). J. Inorg. Nucl. Chem.; 34: No. 5, 1479-83(May 1972).

The yields of 40.1 min ^{123}Sn, 9.6 min ^{125}Sn and ^{128}Sn from thermal–neutron induced fission of ^{235}U were determined to be 0.0140 ± 0.0011, 0.0192 ± 0.0017 and 0.333 ± 0.024%, respectively. The yields were determined by comparison of the γ-ray intensities with a Ge(Li) detector of these fission products in chemically separated tin samples with intensities of γ rays from ^{97}Zr (^{97}Nb) and ^{132}Te(^{132}I) in chemically separated samples. The new yield values for 40.1 min ^{123}Sn and ^{128}Sn are in agreement with previously reported values, but the new value for 9.6 min ^{125}Sn is considerably larger than the previously reported value. However, the new value is consistent with the difference between the ^{125}Sb and 9.6 day ^{125}Sn yields. The recommended values for the yields of 40.1 min ^{123}Sn, 9.6 min ^{125}Sn and ^{128}Sn are: 0.014 ± 0.001, 0.018 ± 0.002 and 0.325 ± 0.015%, respectively. (auth) (UK)

34973 MASS YIELD DISTRIBUTION AND CHARGE DISPERSION IN 450 MeV PROTON FISSION OF ^{238}U. Panontin, J. A.; Sugarman, N. (Univ. of Chicago). J. Inorg. Nucl. Chem.; 34: No. 5, 1485-1502(May 1972).

The independent and/or cumulative cross-sections of 26 isotopes of silver, cadmium, indium, tin, and antimony from the fission of ^{238}U with 450 MeV protons were measured. The isotopic yield distribution for these elements is presented along with the charge dispersion for six mass chains, 109, 115, 117, 125, 127 and 129. The values of the most probable charge, Zp, for 14 mass chains were calculated and the variation of A/Zp with A in the mass region 100 to 130 was determined. For A values between 100 and 120, the value of A/Zp is relatively constant at a value of 2.424 ± 0.004 if the charge dispersion width is assumed to be constant at a value of 2.90 ± 0.10 Z units. In the mass region, 125 to 129, a width of 3.21 Z units and a slightly higher value of A/Zp, 2.430 ± 0.004, are required to account for the data. A mass yield curve encompassing this region of A was also determined. (auth)

34974 SEARCH FOR INTERMEDIATE SUBSTRUCTURES IN THE FISSION CROSS SECTION OF ^{232}Th + n. Konecny, E. (Technische Univ., Munich); Busse, W.; Efken, B.; Finckh, E.; Pietrzyk, P. Z. Phys.; 251: No. 5, 400-3(1972). (In German).

The resonances in the ^{232}Th(n,f) reaction at $E_n = 1.61$ and 1.72 MeV were examined for fine structure. With the experimental resolution of 8 keV no resolved fine structure was observed. (auth)

34975 ELECTRON CAPTURE DECAY OF ^{238}Am AND ELECTRIC MONOPOLE TRANSITIONS IN ^{238}Pu. Ahmad, I.; Sjoblom, R. K.; Barnes, R. F.; Wagner, F. Jr.; Fields, P. R. (Argonne National Lab., Ill.). Nucl. Phys.; A186: No. 3, 620-40(1972).

Mass-separated samples of ^{238}Am ($T_{1/2}$ = 98 min) have been used to investigate the EC decay scheme of ^{238}Am. The γ-ray and conversion electron spectra were measured with high-resolution Ge(Li) and Si(Li) spectrometers. Several electric monopole transitions were identified. The K/L ratios of the E0 transitions are in agreement with the theoretical values of Church and Weneser. A γ-ray spectrum was measured in coincidence with the electron lines of the 44.1 keV transition in order to distinguish transitions going to the ground state from those terminating at the 2^+ or 4^+ member of the ground state band. From these data a decay scheme has been constructed. Assignments of levels already known from the β^- decay of ^{238}Np and α-decay of ^{242}Cm have been confirmed. Several other low-spin states have been postulated to account for the observed γ-rays and conversion electrons. From log ft value considerations the ground state of ^{238}Am has been given an assignment of $\{n[743]{}^{7}\!/_{2}{}^{-};\ p[523]{}^{5}\!/_{2}{}^{-}\}1^{+}$ and the 962.8 keV level of ^{238}Pu has been assigned to $\{n[743]{}^{7}\!/_{2}{}^{-};\ n[622]{}^{5}\!/_{2}{}^{+}\}1^{-}$. The half-life of ^{238}Am has been measured to be 98 ± 3 min. A 5.94 MeV α-group has been assigned to ^{238}Am decay. The α-branching has been measured to be $(1.0 \pm 0.4) \times 10^{-4}$%. (auth)

34976 LIFETIME ESTIMATES FOR ASYMMETRIC FISSION OF ^{240}Pu, INCLUDING SHELL EFFECTS. Ledergerber, T.; Pauli, H. C. (Univ., Basel). Phys. Lett.; 39B: No. 3, 307-10(1 May 1972).

The lifetime for spontaneous fission of ^{240}Pu is evaluated in an adiabatic approach with the WKB-approximation, where left-right asymmetry is taken into account in both the potential (Strutinsky's method) and the kinetic energy (cranking model). The ratio of the lifetimes for symmetric and asymmetric fission agrees with the available data. The predicted peak-to-peak ratio in the fragment mass distribution is slightly larger (~1.5) than the experimental one. (auth)

34977 PRECISION MEASUREMENT OF TRANSITION AND LEVEL ENERGIES IN ^{233}U. von Egidy, T.; Schult, O. W. B.; Kallinger, W.; (and others) (Technische Univ., Munich. Danish Atomic Energy Commission, Risoe). Z. Naturforsch.; 26a: No. 6, 1092(Jun 1971).

The energy level scheme of ^{233}U was developed from a study of the γ spectra accompanying the decay of ^{233}Pa. Level energies were determined to an accuracy of about 20 eV. (J.W.R.)

34978 PRECISION MEASUREMENT OF HALF-LIFE AND SPECIFIC ACTIVITY OF ^{236}U. Flynn, K. F.; Jaffey, A. H.; Bentley, W. C.; Essling, A. M. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem.; 34: No. 4, 1121-9(Apr 1972).

Using a method developed earlier, a precision measurement of the specific activity of ^{236}U was made. Samples were prepared by molecular plating and counted in an intermediate geometry alpha proportional counter with a flat pulse height plateau. The small amount of residual non-plated uranium was corrected for by counting in a 2π-counter. A silicon junction detector was used for energy analysis to detect non-^{236}U α-activity. The measured specific activity was 143604 ± 84 d/m/mg ^{236}U, corresponding to a half-life of $(2.3415 \pm 0.0014) \times 10^{7}$ yr. (auth)

34979 DISTRIBUTION OF MASS IN THE SPONTANEOUS FISSION OF ^{256}Fm. Flynn, K. F.; Horwitz, E. P.; Bloomquist, C. A. A.; (and others) (Argonne National Lab., Ill.). Phys. Rev., C; 5: No. 5, 1725-9(May 1972).

The distribution of mass in the spontaneous fission of ^{256}Fm was investigated by the radiochemical determination of the fission yields for 28 mass chains. The mass distribution is asymmetric with a peak-to-valley ratio of ~12. The average masses of the light and heavy groups are 111.9 and 141.0, respectively. The fission-yield data indicate a value of 3 ± 1 for $\bar{\nu}$, the average number of neutrons emitted per fission. A comparison of the characteristics of the mass distribution for low-energy fission of nuclides ranging from ^{227}Th to ^{256}Fm is given. (4 figures, 2 tables) (auth)

34980 ENERGY LEVELS IN ^{239}Pu POPULATED BY ELECTRON-CAPTURE DECAY OF 11.9-h ^{239}Am. Porter, F. T.; Ahmad, I.; Freedman, M. S.; (and others) (Argonne National Lab., Ill.). Phys. Rev., C; 5: No. 5, 1738-51(May 1972).

Gamma singles spectra of mass-separated ^{239}Am(11.9 ± 0.1 h) samples were measured with high-resolution Ge(Li) detectors. Conversion-electron spectra were measured at 0.1% resolution with a magnetic spectrometer and also with a cooled Si(Li) detector. An M1 multipolarity was found for the weak 124.42-keV transition from the previously known 511.84-keV state to the ${}^{9}\!/_{2}{}^{+}$ level at 387.42 keV. The 511.84-keV state in ^{239}Pu is therefore designated as the spin-${}^{7}\!/_{2}$ member of the ${}^{7}\!/_{2}$+(624) Nilsson state. New, very weak intraband transitions (101.96 keV, E2 and 57.3 keV, predominantly M1) depopulating the ${}^{9}\!/_{2}{}^{+}$ state at 387.42 keV support its spin assignment. Atomic electron binding energies for the K, N_{1-4}, O_2, and O_3 shells in Pu were obtained; small revisions in best values for Pu electron binding energies are suggested. Log ft values for the electron-capture transitions $^{239}\mathrm{Am} \rightarrow {}^{239}\mathrm{Pu}$ were derived. (7 figures, 6 tables) (auth)

34981 0^+ EXCITED STATES IN THE ACTINIDES. Chasman, R. R. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 28: No. 19, 1275-7(8 May 1972).

A calculation of 0^+ excited states in the actinides is presented for a pairing-force theory of the type suggested by Griffin, Jackson, and Volkov. Contrary to previous results, it is found that such a theory does not explain low-lying 0^+ excited states in the actinides any better than does a conventional pairing-force theory. (auth)

34982 SEARCH FOR CONVERSION ELECTRONS POPULATING THE ^{236}U FISSION ISOMER. Konecny, E. (Technical Univ., Munich); Specht, H. T.; Weber, J.; (and others). Nucl. Phys.; A187: No. 2, 426-32(1972).

A measurement of delayed coincidences between conversion electrons and fission fragments from the isomeric fission of ^{236}U induced by thermal neutron capture in ^{235}U is reported. No statistically significant effect from conversion electrons preceding isomeric fission has been found. An upper limit of 5×10^{-5} is deduced for the isomeric to prompt fission ratio. (auth)

34983 NUCLEAR ORIENTATION STUDY OF THE DECAY OF ^{239}Np POLARIZED IN ZrFe$_2$: PARITY MIXING IN ^{239}Pu AND NUCLEAR STRUCTURE OF ^{239}Pu AND FISSION PRODUCTS $^{131\ 132\ 133}$Xe. Krane, K. S.; Olsen, C. E.; Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 5: No. 5, 1671-8(May 1972).

Investigations of the angular distribution of γ radiation from ^{239}Np polarized at low temperatures in ZrFe$_2$ suggested small forward–backward asymmetries for several of the hindered E1 and M1 γ transitions of ^{239}Pu. From the anisotropies of the γ-ray angular distributions, the following multipole mixing ratios were deduced: E2/M1 : $\delta(210) = -0.02 \pm 0.02$, $\delta(228) = -0.07 \pm 0.03$, $\delta(254) = -0.12 \pm 0.06$, $\delta(278) = +0.16 \pm 0.03$; M2/E1 : $\delta(106) =$

+0.05 ± 0.03, $\delta(316) = -0.10 \pm 0.12$, $\delta(334) = +0.02 \pm 0.03$. The small E2/M1 mixing ratios of the $\Delta K = 2$ transitions are explainable in terms of Coriolis mixing. The 512-keV level of ^{239}Pu was identified as the $^{7}\!/_{2}{}^{+}$[624] Nilsson state, which assignment yields the E2/M1 mixing ratio $\delta(182) = -0.12 \pm 0.08$. The hyperfine splitting of ^{239}Np in $(U_{0.005}Zr_{0.995})Fe_2$ was determined to be 60 ± 5 mK. Difficulties encountered in the selection of a suitable ferromagnetic environment for ^{239}Np are discussed. Spin assignments and γ-ray multipole mixing ratios in ^{131,132,133}Xe were deduced from angular distributions of γ rays following the decays of fission products ^{131,132,133}I. (3 figures, 5 tables) (auth)

34984 SATELLITE BANDS OF INTERNAL CONVERSION ELECTRON LINES. **Walen, R. J.; Valadares, M.; Briancon, C. (Centre National de la Recherche Scientifique, Orsay, France). J. Phys. (Paris), Colloq.; No. 4, 145-50(1971). (In French).**

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

Experimentally observed satellite bands in conversion electron spectra are compared with theoretical calculations based on calculating the binding energy as a function of the atomic ionization using a relativistic HFS method. Comparative measurements of the half-life of the 59.5-keV excited state of ^{237}Np were made for neutral and heavily charged atoms. (France)

Nuclear Theory

Refer also to abstracts 34586, 34676, 35364, and 35380.

34985 (IAE-2079) METHOD FOR INVESTIGATING CORRELATIONS IN NUCLEAR REACTIONS. **Vinogradov, A. A.; Gol'dberg, V. Z.; Kurashov, A. A.; Paramonov, V. V.; Petrov, I. P.; Pudakov, V. P.; Serikov, I. N.; Chesalov, A. A. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).**

A technique for studying correlations between charged particles produced in nuclear reactions is described. A recording system aids in the analysis of coincident particles according to mass (charge) with a precision of ≃10%, according to their energy (≃1 to 2%), and the angle of flight (±1 to 2%). The resolution time of the coincidence circuit is 10 to 40 nsec. (tr-auth)

34986 (IAE-2096) CONSTRUCTION OF A MICROSCOPIC THEORY FOR NUCLEAR REACTIONS. **Drozdov, S. I. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 31p. (In Russian). Dep. NTIS (U. S. Sales Only).**

A survey is given of the contemporary phenomenological many-particle theory of nuclear reactions in the form proposed by MacDonald. Resonance scattering is examined in connection with a single-particle quasi-stationary level. Reaction theory of the entrance channel resonance and its fine structure is discussed. As an example of the width of input resonance, there is submitted a calculation of the proton width of the analog resonance. (1 table) (tr-auth)

34987 (ISS-71/23) HIGH-ENERGY SCATTERING OF ELECTRONS FROM NUCLEI. **Ciofi degli Atti, C. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). 13 Sep 1971. 67p. Dep. NTIS (U. S. Sales Only).**

The basic theory of electron scattering is briefly reviewed. The theoretical interpretations of the latest experimental data on elastic and inelastic scattering are presented and discussed. Particular attention is given to the problems of the study of short range correlations and of single particle momentum distributions and separation energies. (auth)

34988 (ITF-71-75-P) ON NONADIABETIC THEORY OF ROTATION-VIBRATIONAL EXCITATIONS IN ATOMIC NUCLEI. **Skorobogatov, P. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).**

Two expressions for potential energy with equilibrium position $\beta_0 \neq 0$ are proposed for describing interactions of rotations with longitudinal β-oscillations in deformed even-even nuclei. In the case of axially symmetric nuclei, as well as in the case of nonaxial nuclei with $\gamma = \gamma_{eff}$ these potential energies enable one to take into account in a nonadiabatic manner the interaction of rotations with oscillations and to obtain an explicit form of the wave functions and spectra of rotation-vibrational collective excitations. (auth)

34989 (ITF-71-93-P) ON THE THEORY OF A SHELL STRUCTURE OF NUCLEI. **Kolomiets, V. M.; Konstantinov, B. D.; Strutinskii, V. M.; Khvorostyanov, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 53p. (In Russian). Dep. NTIS (U. S. Sales Only).**

A shell correction model is formulated in order to describe the oscillations of nuclear masses and other phenomena related to nucleon shells. In theory, the deviation of the actual nucleon distribution from that averaged statistically plays the role of a small parameter. In the formal expansion, the terms up to the second order are taken into account. These terms depend on the nucleon pair interaction (the scattering amplitude). The connection between the shell oscillations of nuclear masses and shell structure effects in the spatial density distribution of nucleon is discussed. The conclusions are illustrated by specific calculations for spherical nuclei. (auth)

34990 (JINR-P2-6290) FERMION PARITY DOUBLETS AND LIGHT NUCLEUS STRUCTURE. **Kopeliovich, B. Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).**

The Gribov-MacDowell's symmetry requires parity doubling of baryons, but the lowest states on some Regge trajectories have no parity partners. The point of view is taken that these nonexisting particles are cancelled by the dynamical zeros of the residue. It is shown in the spirit of the Van Hove model that, if the residue of a given trajectory passes zero at some value of μ, then one-particle-exchange amplitudes for any state on this trajectory fall to zero at the same μ. The convergence of the sum in the physical region (the strongest proposition of the Van Hove model) is not needed. Thus, the absence of the nucleon parity partner causes zeros both in nucleon residue and one-nucleon-exchange amplitude at the same value of μ. The vertex functions of virtual emission of the nucleon by light nuclei, which take part in some one-nucleon-exchange reactions, are analyzed. It is found that these vertex functions really go through zero when $\sqrt{\mu} = \sqrt{\mu_0}$. The numerical values of $\sqrt{\mu_0}$ are presented for a few forms of wave functions for the nuclei d, ^{3}He, and ^{4}He. The vertex functions for ^{3}He and ^{4}He were calculated in connection with p-^{3}He and p-^{4}He backward scattering. Because of the μ-channel unitarity condition the values of $\sqrt{\mu_0}$ for different vertices should coincide. A small difference between $\sqrt{\mu_0}$ and d and ^{3}He, ^{4}He is explained, perhaps, by the influence of configuration mixing and the simplicity of the wave function parametrization for ^{3}He and ^{4}He. This nucleon residue zero can cause dips in the energy dependence of some reactions with nucleon exchange. For instance, the energy dependence of the p-d backward scattering cross section should have a dip in the proton energy interval $T_p = 1.13$ to 1.19 GeV. In addition, just after the dip, the angular dependence must show a minimum at $\theta = 180°$, which disappears when T_p increases. The experimental data at $T_p = 1.18$ GeV justify this statement. The situation with other models for this case is discussed. Since zeros in nuclear vertex functions are generated by the nucleon-nucleon core, the understanding of the relation between the nucleon core and the absence of the nucleon parity partner is needed. This problem is discussed in the framework of the quark model. (2 figures, 1 table) (auth)

34991 (JUL-817-KP) INFLUENCE OF PAIR CORRELATION ON THE ROTATIONAL STATES OF LIGHT ATOMIC NUCLEI. **Goeke, Klaus (Kernforschungsanlage, Juelich (West Germany). Institut fuer Kernphysik). Dec 1971. 67p. (In German). Dep. NTIS (U. S. Sales Only).**

Thesis. Submitted to Muenster Univ. (West Germany).

It was attempted to clarify the rotational states of a nucleus exclusively on the basis of the nucleon-nucleon interaction. Especially studied was the effect of pair correlations. The Hartree-Bogolubov method (HB) with subsequent rotational impulse projection was used and the results were compared with both the Hartree-Fock method (HF) with subsequent projection and with experimental findings. Since the two methods failed to yield good quantum numbers, data were interpreted as superposition of the rotational properties of the ground state. The method of rotational impulse projection permitted separation of single components in the superposition. Corresponding calculations were performed which included the pairings proton-proton, neutron-neutron, and proton-neutron. (H.B.G.)

34992 (KFKI-72-17) ENERGY SPECTRA OF NEUTRONS FROM (n,n') AND (n,2n) REACTIONS. **Kluge, Gy.; Jeki, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Feb 1972. 16p. Dep. NTIS (U. S. Sales Only).**

The compound nucleus model was used in cross section calculations for two-step cascade emissions in (n, n') and (n, 2n) reactions initiated by 14-MeV neutrons on several nuclei. The results were compared with experimental data. (J.W.R.)

34993 (RLO-1388-168) SINGLE-PARTICLE EFFECTS ON FISSION PROBABILITIES FOR THE LIGHTER ELEMENTS. **Vandenbosch, R.; Mosel, U. (Washington Univ., Seattle). [1972]. 11p. Dep. NTIS.**

The excitation energy dependence of the competition between neutron emission and fission has been calculated for nuclei in the vicinity of the ^{208}Pb closed shell. A two-center shell model has been used to calculate single particle effects on the nuclear level density as well as on the barrier heights. Comparison with experiment demonstrates the importance of including the dependence of the single particle level density on deformation. (auth)

34994 (UCRL-Trans-10595) METHOD FOR CALCULATING THE ENERGY DEPENDENCE OF THE MASS CHAIN YIELD FOR FISSION. Tasaka, Kanji; Seki, Yasuchi (Japan Atomic Energy Research Inst., Tokyo). Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from report JAERI-Memo-4383. 48p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 56816.

34995 SURFACE δ-INTERACTION MODEL FOR DOUBLY OPEN SHELL NUCLEI. I. QUADRUPOLE VIBRATIONS. Goswami, Amit (Univ. of Oregon, Eugene); Lin, Lu. Nucl. Phys.; A186: No. 1, 88-96(1972).

The surface-δ interaction (SDI) of Moszkowski is applied to calculations of quadrupole vibrational states of spherical nuclei with the following special features: (i) The spin-dependence of the force is treated correctly. This is important for doubly open-shell nuclei. (ii) The phase of the single-particle wave functions at the surface is taken into account. This is important for the calculation of the E2 transition probability from the one-phonon state to the ground state. Numerical calculations are presented for the Ni−Zn region and the Te−Ba−Xe region. The results are compared with the predictions of the pairing-plus-quadrupole model and with experiment. The agreement with experiment is very good. (auth)

34996 PERIPHERAL MODEL FOR A STRIPPING REACTION TO A RESONANCE STATE. Dzhamalov, P. O.; Dolinskii, E. I.; Mukhamedzhanov, A. M. (Moscow State Univ.). Yadern. Fiz.; 15: No. 2, 258-71(Feb 1972). (In Russian).

A simple model is proposed to describe a stripping reaction to a resonance state of the final nucleus in the framework of the dispersion theory of direct processes. As concrete examples it is shown that comparison of the differential cross sections for (d,p) reactions calculated in this model with experimental ones yields information on the orbital momentum, spin, and neutron width of the resonance level. (auth)

34997 NONADIABATIC THEORY OF THE ROTATIONAL-VIBRATIONAL EXCITATIONS IN ATOMIC NUCLEI. Skorobogatov, P. V. (Kiev State Univ.). Yadern. Fiz.; 15: No. 2, 220-5 (Feb 1972). (In Russian).

To describe the interaction of the rotations with longitudinal β vibrations in deformed even−even nuclei two expressions for the potential energies with an equilibrium position $\beta_0 \neq 0$ are proposed. In the case of axially symmetric nuclei and nonaxial nuclei with $\gamma = \gamma_{\text{eff}}$ as well these, potential energies permit one to take into account nonadiabatically the vibration−rotation interaction and obtain the explicit form for the wave functions and spectra of the rotational−vibrational collective excitations. (2 figures, 1 table) (auth)

34998 KINEMATICAL PARAMETERS OF NUCLEAR REACTIONS. Wolfram, Amy; Moore, C. Fred; Coker, W. Rory (Univ. of Texas, Austin). Comput. Phys. Commun.; 2: No. 7, 443-8 (Dec 1971).

The program NUCLEAR SPECTRA calculates various parameters of nuclear reactions; given the charge and mass of the projectile, target, and emitted nuclei of interest, the incident energy, and the lab angle at which reaction products are observed, the program calculates the energy, inverse velocity, and momentum of the final reaction products as well as the Q value of the reaction at the given reaction angle. The output also includes the specific residual nuclear states excited. The program does a classical relativistic calculation based on first principles of conservation of energy and momentum and accurate to the number of significant bits in the computer word length. The code can accommodate four hundred individual reactions per data set. Written in FORTRAN for the CDC 6600, it requires 77,777 60-bit words of storage. The running time for a calculation involving one projectile incident at one energy on four targets with five nuclei emitted at one angle is 14 seconds. (1 figure, test run output) (R.W.R.)

34999 PROGRAM TO CALCULATE INTERNAL CONVERSION COEFFICIENTS FOR ALL ATOMIC SHELLS WITHOUT SCREENING. Dragoun, O.; Heuser, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Comput. Phys. Commun.; 2: No. 7, 427-32 (Dec 1971).

This program, INTERNAL CONVERSION COEFFICIENTS, calculates internal conversion coefficients for all atomic subshells from K to Q_1. The formulas used are based on an analytical solution of the Dirac equation for electrons in the pure Coulomb field of a point nucleus. The finite-nuclear-size correction is included. The conversion coefficients computed with this program and corrected approximately for atomic screening were found to be in good agreement with experiment. The method is especially useful in cases where no precise conversion coefficients are available. The gamma function of complex argument is evaluated by using the asymptotic and recurrence formulas. The hypergeometric function of complex variables is computed from the hypergeometric series inside the circle of convergence and by an analytical continuation outside this region. The program was tested successfully for all atomic subshells (K to Q_1), atomic numbers $Z \leq 100$, for electric and magnetic multipoles with $1 \leq L \leq 5$ and for transition energies higher than the electron binding energy in the pure Coulomb field up to 17 MeV. This program, in FORTRAN IV for the CDC 3300, requires 4659 24-bit words of storage. The evaluation of the K-shell conversion coefficient takes two to six seconds on the CDC 3300; to calculate the P_5 subshell conversion coefficient for the 2^5-pole electric transition requires about 70 s. (1 figure, 2 tables, test run output) (R.W.R.)

35000 SU3 FRACTIONAL PARENTAGE IN THE 1p-SHELL. Meyer, J.; Nahabetian, R. S.; Joseph, J.; Lafoucriere, J. (Institut de Physique Nucleaire, Villeurbanne, France). Comput. Phys. Commun.; 2: No. 7, 420-6(Dec 1971).

Elliott's SU3 model is used to calculate the fractional parentage coefficients occurring in matrix elements for various m-particle operators (m = 1,2,3,4) and in reduced widths of the p-shell nuclei for deuterons, tritons, and α particles. The program named 1PSHELL SU3 fractional parentage, is written in FORTRAN for the CDC 6600 and requires 19,905 60-bit words of storage. Average calculation times vary from less than 1 ms for the $n|n-1$ coefficients to about 2 s for the $n|n-4$ ones. The test run (including compilation) requires 26 s on a CDC 6600. (2 figures, test run output) (R.W.R.)

35001 EFFECTS OF A PARITY-VIOLATING INTERACTION IN AN EXACTLY SOLUBLE MODEL. Hernandez, E. S. (Univ., Buenos Aires); Plastino, A. Lett. Nuovo Cim.; 3: No. 14, 601-4(1 Apr 1972).

The parity-mixing problem in Hartree−Fock calculations is studied within the context of an exactly soluble model. In this case it is possible to solve the projection-before-variation (PBV) equations without recourse to parametrization. The model Hamiltonian is modified to allow forward scattering and parity mixing. The tabulated results show that the PBV method may yield significant differences as compared with the projection-after-variation (PAV) method. The importance of projecting before variation is shown by the gain in binding energy observed, even with respect to the parity projection energy which comes from the exact calculation. The parity admixture effects of the parity-violating Hamiltonian are seen to be more intense in the PBV case. The difference between PBV and PAV becomes smaller as the strength of the interaction or the number of interacting particles increases; when the parity admixture is large enough, the way in which the projection is done becomes irrelevant. Since the parity-admixture effects of nuclear forces are known to be small, however, the use of the PBV method in realistic situations is preferred. (1 table) (R.W.R.)

35002 CALCULATION OF ELECTRIC QUADRUPOLE RADIAL MATRIX ELEMENTS FOR COULOMB EXCITATION. Samuel, M.; Smilansky, U. (Weizmann Inst. of Science, Rehovot, Israel). Comput. Phys. Commun.; 2: No. 7, 455-69(Dec 1971).

The code ITER calculates radial matrix elements $M_{l_i l_f}^{-3}$ for E2 or M1 Coulomb excitation up to $l_i = 500$ with $l_f = l_i, l_i \pm 2$. These elements are used in the calculation of scattering amplitudes associated with inelastic scattering of charged particles by nuclei by the partial-wave expansion. Monopole matrix elements M_{ll}^{-1} are calculated by a downward recursion and normalized by a direct calculation of M_{ll}^{-1}. Quadrupole matrix elements with $l_f = l_i + 2$ are calculated in the same way. Upward recursions are used to calculate M_{ll}^{-3} and $M_{l+2,l}^{-3}$. Written in FORTRAN IV, the program requires 7700 75-bit words of storage in the GOLEM computer. The program takes about 1.7 min to compile; execution varies between 2 and 18 s for one case. Running time on a CDC 3400 is about the same. (3 figures, test run output) (R.W.R.)

35003 CONSISTENCY OF THE RANDOM PHASE APPROXIMATION. Ullah, N. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett.; 39B: No. 2, 173-5(17 Apr 1972).

The effect of using various correlated ground states on the energies of excited collective RPA states is examined. It is shown that, if the exact correlated state given by Lipkin, Meshkov, and Glick is used as a variational correlated ground state, then the energies of the excited states are closer to their exact values than the ones given by the exact particle−hole model. (auth)

35004 SATURATION MECHANISMS AND ALPHA PARTICLE CLUSTERING IN LIGHT NUCLEI. Lassey, K. R.; Volkov, A. B. (McMaster Univ., Hamilton, Ont.). Phys. Lett.; 39B: No. 2, 169-72(17 Apr 1972).

It is demonstrated that the extent of density clustering in light A = 4n nuclei, as given by Hartree—Fock calculations, depends rather sensitively upon the saturating mechanism of the interaction being used. The example carried through in detail is that of ^{20}Ne. (auth)

35005 Q-VALUE DEPENDENCE OF THE CROSS SECTION OF HEAVY ION REACTIONS. Abul-Magd, A. Y.; El-Abed, K.; El-Nadi, M. (Cairo Univ.). Phys. Lett.; 39B: No. 2, 166-8 (17 Apr 1972).

The exponential dependence of the cross section of multinucleon transfer reactions induced by heavy ions is interpreted in the framework of the statistical theory of nuclear reactions. (auth)

35006 CONSISTENCY OF THE QUASI PARTICLE RANDOM PHASE APPROXIMATION. Hernandez, E. S. (Univ., Buenos Aires); Plastino, A. Phys. Lett.; 39B: No. 2, 163-5(17 Apr 1972).

The consistency of the quasi-particle random phase approximation is tested by determining the quasi-particle occupation numbers in the ground state of rare earth nuclei. Effects of the schematic approximation are discussed. (auth)

35007 BEHAVIOR OF THE G-MATRIX EXPANSION FOR THE AVERAGE EFFECTIVE INTERACTION. Goode, P.; Koltun, D. S. (Univ. of Rochester, N. Y.). Phys. Lett.; 39B: No. 2, 159-62(17 Apr 1972).

A method is presented for calculating the spectroscopic average of higher-order terms in the G-matrix expansion of the nuclear effective interaction. Results for the 1d—2s and 1f—2p shells show that the expansion is well-behaved on the average through third order, in contrast to earlier results for J, T = 0, 1 states. (auth)

35008 SINGLE-PARTICLE MODEL CALCULATION OF TOTAL ENERGY SURFACES IN HEAVY NUCLEI. Maharry, David E. Lawrence, Kan.; Univ. of Kansas (1971). 138p. University Microfilms Order No. 72-11,771.

Thesis.

The total energy surfaces for heavy nuclei have been calculated using a double-center oscillator, single-particle potential. The energy surfaces are calculated using the summation method of Nilsson in which the virial term, proportional to $\langle T-V\rangle$, has been calculated explicitly. It is found that this term significantly influences the shape of the energy surface and the calculated height of the fission barrier. The fission barrier for ^{236}U is reduced by 77 MeV with the inclusion of this term. Equilibrium deformations, fission barrier heights and shape isomer excitation energies for nuclei ranging from ^{230}Th to ^{256}Fm are calculated and compared with experimental data as well as other theoretical calculations. It is found that the calculated fission barrier heights are in reasonable agreement with the experimental data if the oscillator parameter, $\hbar\mathring{\omega}_0$, is chosen so that the single-particle level density of the model equals that experimentally observed in the actinide region. Isomeric states, ranging in energy from 2 to 3 MeV, are predicted in nuclei from thorium to curium but are absent in the heavier elements. In thorium the calculations predict that the inner barrier is quite small and spontaneous fission would not likely be observed. In the heavier isotopes of uranium, the lighter isotopes of curium, and virtually all of the isotopes of plutonium and americium, the calculated barriers are of nearly equal size. The outer barrier predicted in the heavier curium isotopes is small and observation of spontaneous fission might be quite difficult. It is shown that these energy surfaces are rather insensitive to the Nilsson spin-orbit parameter κ. The quadrupole deformation of the ground state of the range of nuclei investigated is about β_2 = 0.25 while that of the isomeric state is about β_2 = 0.70. (Diss. Abstr. Int., B)

35009 INVESTIGATION OF COULOMB ENERGIES IN THE NUCLEAR 1p SHELL. Anderson, Ronald Keith. Lawrence, Kan.; Univ. of Kansas (1971). 171p. University Microfilms Order No. 72-11,724.

Thesis.

A formalism for the analysis of nuclear Coulomb energies is developed for the 1p shell in which the matrix elements of the Coulomb perturbation are evaluated with correlated wavefunctions obtained in realistic nucleon-nucleon potentials through a reference-spectrum solution of the Bethe—Goldstone equation. Coulomb shifts in the excited states, displacement energies, total Coulomb energies, and isospin mixing are computed with reasonably consistent results, but are subject to deviations from inherent size fluctuations, since the interaction parameters are held constant throughout the shell. Correlated wavefunctions were found to be generally superior to oscillator orbitals, particularly for the analysis of exchange effects. (Diss. Abstr. Int., B)

35010 PROMPT NEUTRON EMISSION AND ASSOCIATED FISSION ENERGETICS RESULTING FROM THERMAL-NEUTRON-INDUCED FISSION. Lee, Walter. Washington, D. C.; Catholic Univ. of America (1972). 110p. University Microfilms Order No. 72-12,657.

Thesis.

A general method, based originally on experimental data, has been developed for predicting the prompt neutron emission and the associated fission energetics resulting from thermal neutron fission. The basis of the method is an approximate formulation for the total excitation energy of complementary fission fragment pairs. A separate expression was derived for the division of the total excitation energy into components for the light and heavy fragments, from which the prompt neutron yields were calculated using a simple model. Average total fragment kinetic energies were calculated from an energy balance using Seeger's semi-empirical mass formula and the postulated excitation energy model. Initial fragment nuclear temperatures were determined from a simple statistical model and were related to the average center-of-mass neutron kinetic energies. Suitable average quantities of interest were obtained by weighting the calculated distributions with initial mass yields, which are the only experimental data used as input to the method. In cases where measured initial mass yields were not available, final mass yields were used in conjunction with the calculated prompt neutron yields to derive initial mass yields. Results of calculations for thermal neutron fission of ^{229}Th, ^{233}U, ^{235}U, ^{239}Pu, ^{241}Pu, and ^{245}Cm are presented and compared with experimental data, where available. The total fragment kinetic energy distributions are on the average predicted to within 0.5 to 1% of measured values. The calculated prompt neutron yield distributions are also in good agreement with experimental results and the value of $\bar{\nu}$, the average number of prompt neutrons per fission, is found to be within 3% of the measured value in the majority of the cases investigated. For thermal neutron fission of ^{245}Cm the calculated value of $\bar{\nu}$ differs about 10% from the experimental value, but is still within the error range of 10 to 25% quoted for the measured mass yields to which the discrepancy is attributed. Neutron spectral parameters characterizing the prompt neutron spectra are calculated to be higher than the "accepted" experimental values, but are more in agreement with some recent experimental results. Based on the comparison of the predicted and measured results, it is concluded that the method can be applied to determine the thermal neutron fission characteristics of a nuclide, for which little or no experimental data is available. (Diss. Abstr. Int., B)

35011 RELATIVISTIC SELF-CONSISTENT FIELD CALCULATIONS FOR NUCLEI. Miller, Lewis Dudley. Gainesville, Fla.; Univ. of Florida (1971). 225p. University Microfilms Order No. 72-12,489.

Thesis.

A self-consistent theory of spherical nuclei is presented which uses the relativistic form of the generalized one Boson exchange potentials (OBEP or GOBEP) for the nucleon—nucleon force. The work is a natural extension of recent nucleon—nucleon calculations with the OBEP models. The OBEP models contain strong velocity-dependent, spin-orbit, etc., (relativistic effects resulting from large cancellations between the static terms which are normally dominant. The use of the relativistic forms of OBEP implies an exact treatment of these non-local effects. The relativistic treatment of the nuclear structure theory is made possible by the use of relativistic-Hartree—Fock theory. This theory enables one to approximately replace an N-body problem with N one-body problems. The relativistic one-body problem is easily solved via the Dirac equation. The OBEP models avoid the infinite repulsive cores characteristic of other phenomenological models of the nucleon—nucleon force. This not only allows the possibility of pure Hartree—Fock calculations (without short-ranged correlations), but significantly decreases the need for correlations in fitting finite nuclear data. Correlation effects for these models are not completely negligible, since the OBEP parameters have been adjusted in fitting finite nuclei; nevertheless, the need for introducing complex density-dependent interactions has been avoided. The strong relativistic effects of the OBEP models carry over into the single-particle domain. The relativistic effects are responsible for the good saturation properties of the relativistic self-consistent nuclear structure theory. Total binding energies, charge distributions, and single-particle eigenvalues for spherical nuclei all agree quite well with experiment. (Diss. Abstr. Int., B)

35012 BOUND STATE SOLUTION OF THE TWO-NUCLEON SCHROEDINGER EQUATION WITH TENSOR FORCES. Lovitch, L; Rosati, S. (Univ., Pisa, Italy. Istituto Nazionale di Fisica

Nucleare, Pisa, Italy). Comput. Phys. Commun.; 2: No. 6, 353-9 (Oct-Nov 1971).

The binding energy and wavefunction of the neutron—proton $J^{\pi} = 1^{+}$ bound state for the cases where the interaction contains a given combination of central, tensor, and spin-orbit potentials are calculated by the DEUT subroutine. DEUT may also be used for nuclear Hartree—Fock calculations employing an effective potential containing a tensor component. DEUT is in FORTRAN IV FOR THE IBM 7090. (J.W.R.)

35013 ELECTROMAGNETIC M1 REDUCED TRANSITION PROBABILITIES FOR PURE AND MIXED NILSSON STATES IN ODD A NUCLEI. Browne, E.; Femenia, F. R. (Facultad de Ciencias Exactas, Buenos Aires). Comput. Phys. Commun.; 2: No. 6, 331-40(Oct-Nov 1971).

The MIXING code for calculating M1 reduced transition probabilities between pure Nilsson single particle states and also between states mixed by Coriolis and $\Delta N = 2$ interactions is described. MIXING is in FORTRAN IV for the Burroughs B 3500 computer. (J.W.R.)

35014 THOMAS–FERMI DESCRIPTION OF NUCLEAR SYSTEMS INCLUDING SPIN–ORBIT INTERACTIONS. Stocker, W.; Suessmann, G.; Knaak, S. (Univ., Munich). Nucl. Phys.; A187: No. 1, 38-48(1972).

The Thomas—Fermi statistical method is generalized to include spin—orbit interactions. The momentum distributions are given by toroids, different for two particle spin orientations. A system of two coupled differential equations is derived by a variational procedure for the densities of the two populations. From these equations the polarization at the surface of nuclear matter is calculated, as well as the change of the nuclear surface tension due to spin—orbit coupling. Within the statistical framework the coupling strength of the spin—orbit potential is found to be in reasonable agreement with experiment by using only the experimental single-particle level order of the shell model which implies an excess of states with spin parallel to the orbital angular momentum. (auth)

35015 ELASTIC SCATTERING AND THE K MATRIX. II. PHASE SHIFTS, RESONANCES, AND FEW-LEVEL APPROXIMATION. Humblet, J. (Univ., Liege). Nucl. Phys.; A187: No. 1, 65-95(1972).

The K-matrix expansions are applied to the scattering by a square-well potential. Their convergence proves very satisfactory from a physical point of view since few-level approximations allow very good approximations to the phase shifts and cross sections. It also appears that all the complex poles of K_l and the real ones with positive residue should undoubtedly be associated with physical resonances. As for the real ones with negative residue, i.e., the echo poles, they are obviously unrelated to resonances, but they provide a very good parametrization of the background part of the scattering. The time delay is given a major role in the argument. The possibility of having double poles is also discussed and sum rules are given for the energies and residues of the poles. (auth)

35016 APPROXIMATE TREATMENTS OF COLLISION INTEGRALS FOR (n,n') INELASTIC SCATTERING AND (n,2n) REACTION. Yamamura, Yasunori; Yamamoto, Kohji; Kitazoe, Yasuhiro; Sekiya, Tamotsu (Osaka Univ.). Technol. Rep. Osaka Univ.; 21: 371-83(Oct 1971).

Approximate treatments of the (n, n′) inelastic scattering and the (n, 2n) reaction of fast neutrons are discussed under the following assumptions: a) The fast neutron is inelastically scattered from a nucleus at rest, leaving this nucleus in a specified excited state. b) The entire analysis is independent of the reaction mechanisms and only depends on the reaction kinematics. c) The (n, 2n) reaction can be treated by the cluster model. The obtained synthetic kernel for the (n, n′) inelastic scattering enables one to treat its collision integral by a simple recursion relation, which may allow rapid computation of the inelastic collision integral. (auth)

35017 CORRELATIONS OF IDENTICAL PARTICLES EMITTED BY HIGHLY EXCITED NUCLEI. Kopylov, G. I.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 2, 392-9(Feb 1972). (In Russian).

Energy and angular correlations of neutrons evaporated from highly excited nuclei are studied. A possibility of the lifetime measurement for excited nuclei in the interval 10^{-18}–10^{-22} sec is discussed. Similar correlations between pions produced in relativistic nuclei collisions permit one to estimate the shape and size of their production region. (auth)

35018 CORRELATION BETWEEN THE PROPERTIES OF LOW LYING COLLECTIVE LEVELS AND FISSION PROCESS OBSERVABLES IN EVEN NUCLEI. Budnik, A. P.; Rabotnov, N. S. (Inst. of Physics and Energetics, Obninsk, USSR). Phys. Lett.; 39B: No. 3, 311-12(1 May 1972).

Effective polynomial potentials for one-dimensional nuclear collective motion leading to fission make it possible to obtain a relation between the spontaneous fission rate, the height of the barrier and the energies of low-lying collective levels. The results are compared with experiment. (auth)

35019 PAIRING INTERACTION IN FINITE FERMI SYSTEMS: APPROXIMATE FULFILLMENT OF THE PAULI PRINCIPLE IN THE GREEN FUNCTION TECHNIQUE. Zawischa, D. (Technische Univ., Hanover). Z. Phys.; 251: No. 5, 387-99(1972).

The Green function method is used to treat pairing correlations in small systems. It is shown that the methods for normal systems can be used in the region of weak or medium interaction strength, provided that the energy dependent contributions to the irreducible particle-particle interaction which are necessary for the fulfillment of the Pauli-principle are not neglected. Comparisons with exact solutions and with other methods are given. (auth)

35020 DOORWAY PARAMETERS OF THE RESONANCES IN SUBTHRESHOLD NEUTRON-INDUCED FISSION. Cugnon, J. (Univ., Liege). Nucl. Phys.; A186: No. 3, 561-73(1972).

A two-channel model is used to extract doorway parameters from resonating subthreshold neutron-induced fission. The decaying width is found to be large compared to the spreading width. Information on the fission strength function is also obtained from this analysis and is compared with the results of an optical-model-type calculation. (auth)

35021 SECOND-ORDER QUANTUM-MECHANICAL THEORY OF COULOMB EXCITATION. Alder, K.; Roesel, F.; Morf, R. (Univ., Basel). Nucl. Phys.; A186: No. 3, 449-74(1972).

The quantum-mechanical theory of Coulomb excitation is discussed. It is shown that the excitation probabilities and cross sections in second-order perturbation theory can be parameterized in a convenient form. The necessary computations can be reduced to integrals of first-order expressions for Coulomb excitation. For the important special case of a quadrupole interaction, the second-order probabilities have been tabulated for a wide range of the physical interesting parameters. Interference terms from the double quadrupole excitation with direct quadrupole or hexadecapole excitation are also discussed and tabulated. (auth)

35022 GENERALIZED GAP EQUATIONS AND THE COHERENCE OF THE $\alpha-\alpha$ PAIR FIELD. Goodman, A. L. (Argonne National Lab., Ill.). Nucl. Phys.; A186: No. 3, 475-92(1972).

Gap equations are derived which include T = 0 pairing correlations between nucleons in identical spatial orbitals ($\alpha-\alpha$ pairing) as well as T = 0 and T = 1 correlations between nucleons in time-reversed orbitals ($\alpha-\bar{\alpha}$ pairing). Solution of the gap equations for the N = Z doubly even nuclei in the s-d shell with the Yale t-matrix demonstrates that $\alpha-\alpha$ correlations can create coherent potentials. Solution of the Hartree—Fock—Bogoliubov equations confirms the coherence of the $\alpha-\alpha$ pair field. (auth)

35023 DOPPLER-SHIFT ATTENUATION FACTOR CALCULATION BY THE MONTE CARLO METHOD. Hanson, W. G.; Puhach, P. A. (Queen's Univ., Kingston, Ont.). Nucl. Instrum. Methods; 100: No. 2, 205-9(1972).

In an effort to resolve a conflict in $F(\tau)$ values calculated by the Monte Carlo method, new results were obtained from an independently-formulated Monte Carlo program. One of the advantages of the new formulation is that no specific value of the mean lifetime need be assumed during the Monte Carlo phase of the calculation. (auth)

35024 NUCLEAR SOFT-CORE POTENTIAL. Rajcev, P. P. God. Sofii. Univ., Fiz. Fak.; 62: 63-74(1967-1968). (In Bulgarian).

A simplified model of a soft-core potential is studied that contains only a few parameters and provides a correct qualitative description of the processes of nucleon dispersion and of the relation between the binding energy, and the average distance between the nuclear particles. The selected potential is qualitatively similar to the potential of Gamow—Teller but contains only five and not 24 parameters. The potential is used for computation of the average energy per particle only for first-order members according to the perturbation theory. The curve obtained for the dependency of the binding energy for one particle on the Fermi impulse provides a correct qualitative description of nuclear matter properties. (Abstr. Bulg. Sci. Lit., Math., Phys., Astron., Geophys., Geod.)

35025 COLLECTIVE ROTATIONAL MOTION IN NONDEGENERATE NUCLEAR SYSTEM. I. GENERAL THEORY. Nishiyama, Seiya; Yamamura, Masatoshi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 47: No. 1, 134-64(Jan 1972).

Following a recent paper of D. H. E. Gross and one of the present authors (M.Y.), the idea of using sum rules expressing different single-particle transition operators in terms of higher powers of other operators is applied for the description of nuclear rotational motion in even deformed nuclei. Starting from the basic picture of Bohr's rotational model, a general microscopic method is developed with the help of these generalized sum rules. The validity of such a picture should be justified by the dynamical restrictions under which rotational motion may appear. Moments of inertia, quadrupole moments, transition probabilities and occupation probabilities of the single-particle states are determined within the framework of the theory. The concept of the intrinsic state is clarified. (auth)

35026 SIX RADIOACTIVITIES. Bell, R. E. Phys. Can.; 28: No. 1, 3-8(1 Jan 1972).

The phenomenon of radioactivity is defined, and six different types, based on the radiation or particle emitted by the nucleus, are enumerated: alpha, beta, and gamma radioactivity, spontaneous fission, delayed neutron emission and delayed proton emission. These types are presented in a historical perspective, from the original discovery through development of the relevant theory to the present point of view. (E.M.T.)

35027 CORRELATIONS OF THE RESONANCE PARAMETERS FOR THE OVERLAPPING RESONANCES. Devi, K. R. Sandhya (Tata Inst. of Fundamental Research, Bombay); Ullah, Nazakat. J. Math. Phys. (N. Y.); 13: No. 3, 316-21(Mar 1972).

A statistical study of the correlations of the complex poles of the unitary collision matrix is carried out. It is shown that both for the elastic and the inelastic scattering the correlation coefficient of the two total widths is always very small. A simple relation satisfied by the correlation coefficient of the real parts of the complex poles is given. The distribution of the single width is calculated and compared with the Porter–Thomas distribution and the one obtained by a numerical calculation. Some other interesting results, like the energy correlation function for the purely elastic scattering cross section and a relation satisfied by the resonance parameters for the fluctuation calculation, are also given. (auth)

35028 RELATIVISTIC SPIN-ZERO WAVE EQUATION. Lepore, Joseph V.; Riddell, Robert J. Jr. (Univ. of California, Berkeley). J. Math. Phys. (N. Y.); 13: No. 3, 405-18(Mar 1972).

The solutions of a wave equation which describes a spin-zero particle in the Coulomb field of a nucleus were studied. An interesting feature of this equation is that the kernel is not of the Fredholm type. The behavior of the momentum space wavefunction for large momentum is not determined solely by the angular momentum state but, as in the cases of the Dirac and Klein–Gordon equations, it depends on the electric charge as well. The analysis of the asymptotic properties is based on a Mellin transformation of the momentum space equation. This leads to a singular integral equation with a Cauchy-type kernel which may be treated by standard methods. The equation is shown to have unique solutions. (auth)

35029 EXPANSION COEFFICIENTS OF MANY-PARTICLE MATRIX ELEMENTS OF A TWO-BODY INTERACTION IN TERMS OF TWO-PARTICLE MATRIX ELEMENTS FOR (j^n) CONFIGURATIONS OF LIKE NUCLEONS. Band, I. M.; Kharitonov, Yu. I. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Data, Sect. A; 10: No. 2, 107-42(Oct 1971).

Presented here are expansion coefficients of many-particle matrix elements of a two-body interaction in terms of two-particle matrix elements for $\{j^n\}$ configurations of identical nucleons. They are tabulated for n up to the half-filled-shell value for $j \leq {}^{11}\!/_2$; for $n = 3,4$ for $j = {}^{13}\!/_2$; and for $n = 3$ for $j = {}^{15}\!/_2$. (auth)

35030 TABLE OF ANGULAR-DISTRIBUTION COEFFICIENTS FOR (GAMMA,PARTICLE) AND (PARTICLE,GAMMA) REACTIONS. Carr, R. W. (Yale Univ., New Haven); Baglin, J. E. E. Nucl. Data, Sect. A; 10: No. 2, 143-204(Oct 1971).

Values are presented in tabular form for the angular-distribution coefficients for photonuclear and radiative-capture reactions in which target and residual spins are $\leq {}^5\!/_2$. By means of the channel-spin formalism, the angular distributions are expressed in terms of Legendre polynomials and nuclear reaction matrix elements. All angular-distribution coefficients are evaluated numerically. A section is included correlating the expressions with those of several standard presentations of angular-momentum theory in nuclear reactions. (auth)

35031 POSSIBLE VALIDITY OF THE RELATIVISTIC HARTREE–FOCK APPROXIMATION IN NUCLEAR PHYSICS. Miller, L. D. (Univ. of Maryland, College Park). Phys. Rev. Lett.; 28: No. 19, 1281-4(8 May 1972).

Although nonrelativistic estimates of single-particle kinetic-energy expectation values appear to have invalidated the Hartree–Fock relation between total binding energy, single-particle eigenvalues, and kinetic-energy expectation values, a recent relativistic Hartree calculation has been successful at reproducing finite nuclear properties for closed-shell nuclei. By using the ^{16}O nucleus, it is demonstrated that this success is due to a reduction in the expectation values of the relativistic analog of the kinetic-energy operator. (auth)

35032 GENERALIZED VARIATIONAL BOUNDS AND SHAPE RESONANCES. Hahn, Yukap (Univ. of Connecticut, Storrs). Phys. Rev., C; 5: No. 5, 1788-91(May 1972).

A simple procedure for estimating individual resonance energies is discussed, in which both shape and compound resonances are treated by a single closed-channel Hamiltonian. The equivalence of the method and the strength eigenvalue problem is proved, and the role of the shift operator in the generalized variational-bounds formulation is further clarified. (auth)

35033 EVEN–ODD EFFECTS IN PRECOMPOUND EMISSION. Lee, Edward V.; Griffin, James J. (Univ. of Maryland, College Park). Phys. Rev., C; 5: No. 5, 1713-17(May 1972).

The precompound theory of particle emissions predicts for the most energetic particles an especially simple dependence of the emission probability upon residual excitation energy. This paper examines this dependence, and compares it with experiment, to obtain the following results: a distinction between processes involving even and odd nuclei; values of single-particle densities, g, of plausible magnitude, whose uncertainties (due to experimental error in the data) are, however, too large to allow a firm conclusion about their energy dependence; and the expectation that a reduction in experimental error by a factor of 2 or 3 might allow a test of a more detailed description of the structure of the residual nucleus. (3 figures, 1 table) (auth)

35034 QUALITATIVE STUDIES OF THE ANGULAR DISTRIBUTION FOR THE (p,n) CHARGE-EXCHANGE REACTION. Whitten, C. A. Jr. (Univ. of California, Los Angeles). Phys. Rev., C; 5: No. 5, 1667-70(May 1972).

For many nuclei the isobaric analog of the target ground state excited in the X(p,n)Y charge-exchange reaction decays by the emission of a single proton ($\tilde{p}$) group. A relation is established for the angular dependence of the centroid energy, $\langle E_{\tilde{p}}(0)\rangle$, for this $\tilde{p}$ group. The measurement of $\langle E_{\tilde{p}}(0)\rangle$ determines the average momentum along the beam direction, $\langle P_{rz}\rangle$, provided the recoiling nucleus Y in the (p,n) charge–exchange reaction is given. The value for $\langle P_{rz}\rangle$ determines the cross-section-weighted average value of $\cos 0_n$ for the (p,n) angular distribution $d\sigma/d\Omega$ (0_n), and thus provides a qualitative characterization of the (p,n) angular distribution. $\langle E_{\tilde{p}}(0)\rangle$ was measured for the ^{116}Sn(p,n$\tilde{p}$) process at 23.15 MeV; and a value for $\langle P_{rz}\rangle$ of 140 MeV/c was determined. The results of this experiment are compared with recent angular-distribution measurements of the (p,n) charge-exchange reaction on the tin isotopes at 23 MeV. (3 figures) (auth)

35035 VARIATIONAL APPROACH TO THE BOUND-STATE FADDEEV EQUATIONS. Harms, Edward (Fairfield Univ., Conn.). Phys. Rev., C; 5: No. 5, 1452-7(May 1972).

A variational principle for the bound-state Faddeev equations is given. This principle takes the form of a variational expression for the linear eigenvalues of the Faddeev kernel. The variational expression is investigated for the case in which the wave function is expanded in terms of known functions. In this case it can be reduced to the variational method of Rosenberg; hence, the energies obtained are variational upper bounds for the bound-state energy. The variational expression is also used to generate a new set of one-dimensional integral equations for the bound-state problem. (auth)

35036 NUCLEON-TRANSFER FORM FACTORS RELATIVE TO A MICROSCOPICALLY SPECIFIED CORE. Philpott, R. J. (Florida State Univ., Tallahassee). Phys. Rev., C; 5: No. 5, 1457-66(May 1972).

A simple model is employed in a preliminary investigation of the influence on measurable quantities of the many-body nature of the interaction experienced by a nucleon participating in a transfer reaction. The model describes a nucleon in dynamic interaction with a microscopically specified core and takes antisymmetry fully into account. Bound and resonant eigenfunctions are determined by the generalized R-matrix method. The nucleon–nucleon interaction is treated phenomenologically and contains central, spin–orbit, and Coulomb terms. Two strength parameters are adjusted to reproduce the observed bound-state energies and low-energy phase shifts of a nucleon in interaction with ^{16}O. The resulting bound form factors have rms radii smaller than those of standard-geometry Woods–Saxon eigenfunctions; these smaller radii lead to important enhancements of spectroscopic factors determined by distorted-wave Born-approximation analyses of reaction data. (7 figures, 3 tables) (auth)

35037 DENSITY-MATRIX EXPANSION FOR AN EFFECTIVE NUCLEAR HAMILTONIAN. Negele, J. W.; Vautherin, D. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., C; 5: No. 5, 1472-93(May 1972).

An expansion for the nuclear wave-function density matrix in relative and cms coordinates is developed such that the leading term is the corresponding nuclear-matter density matrix at the local neutron and proton density. Truncation of all derivatives beyond second order yields an extremely simple form for the energy density which retains all the computational simplicity of the modified δ interaction and the Skyrme force while maintaining contact with nuclear-matter theory based on a realistic interaction and reproducing the results of more complicated density-dependent Hartree–Fock calculations. (3 figures, 3 tables) (auth)

35038 SUFFICIENT CONDITIONS FOR SATURATION OF NUCLEAR FORCES. Calogero, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Simonov, Yu. A.; Surkov, E. L. Phys. Rev., C; 5: No. 5, 1493-1508(May 1972).

Conditions are given and proven that are sufficient to insure the saturation property of nuclear binding energies. Interactions mediated by two-body local static potentials are considered. For some classes of potentials these sufficient conditions are also necessary for saturation. (2 figures) (auth)

35039 TESTS FOR T INVARIANCE IN ALLOWED NUCLEAR BETA DECAY. Holstein, Barry R. (Univ. of Massachusetts, Amherst). Phys. Rev., C; 5: No. 5, 1529-34(May 1972).

Various tests of T invariance involving allowed nuclear β decays are discussed. T-violating correlations are calculated to first order in recoil terms E/M and electromagnetic final-state-scattering corrections are given. (auth)

35040 SIMPLE FORMULA FOR THE GENERAL OSCILLATOR BRACKETS. Trlifaj, L. (Nuclear Research Inst., Rez, Czech.). Phys. Rev., C; 5: No. 5, 1534-9(May 1972).

An explicit formula for Talmi–Moshinsky transformation brackets of unequal-mass particles is given which is the sum of simple expressions over five variables; it is especially suited for numerical calculations. (auth)

35041 SUBSIDIARY CONDITIONS ON NUCLEAR MANY-BODY THEORIES. Clark, J. W. (Institutionen foer Fysik, Abo, Finland); Ristig, M. L. Phys. Rev., C; 5: No. 5, 1553-61(May 1972).

In the Jastrow theory applied to low cluster order it is necessary to restrict the variation of the two-body correlation factor f(r) to the domain of functions corresponding to acceptable convergence of the cluster expansion for the energy. Two constraints which have received some attention are examined in detail: the "normalization condition" and the "orthogonality (or average Pauli) condition." The former constraint is motivated by the requirement that the liquid structure factor S(k) vanish at zero wave number; the latter, by the Pauli principle in the Fermi medium. It is shown that two-body Jastrow theory cannot obey both constraints exactly for a state-independent correlation factor $f \not\equiv 1$, but that the requirement $S(0) = 0$ is automatically satisfied in (two-body) Brueckner reaction-matrix theory as a trivial consequence of the fulfillment, by definition of this theory, of the Pauli principle in the medium. (auth)

35042 MODIFIED TAMM–DANCOFF APPROXIMATION FOR PAIRING VIBRATIONS. Ghosh, M. K.; Goswami, A. (Univ. of Oregon, Eugene). Phys. Rev., C; 5: No. 5, 1581-7(May 1972).

The modified Tamm–Dancoff approximation (MTDA) for pairing vibrations is studied. It is shown that the previously reported success of the method is connected with the fact that seniority is a fairly good quantum number for nuclear ground states. It is pointed out that the MTDA may be useful for the treatment of pairing correlations in deformed nuclei. Numerical calculations are presented for ^{24}Mg. The random-phase-approximation extension of the method is carried out and used to calculate pairing correlations in ground and excited states of the Pb isotopes. (1 figure, 2 tables) (auth)

35043 MONTE CARLO STUDIES OF A CLASS OF REAL SYMMETRIC MATRICES. Bohigas, O.; Brody, T. A.; Flores, J.; Mello, P. A.; Yepez, E. (Univ. Nacional, Mexico City). Rev. Mex. Fis.; 20: No. 4, 217-30(1971).

A class of ensembles of real symmetric matrices H is defined by $H = A_1^T A_1 + \xi^2 A_2^T A_2$ where the A_i are real asymmetric matrices whose elements are independent Gaussian random variables. By means of Monte Carlo calculations the density and spacing distributions of the eigenvalues are studied. For all values of ξ^2 considered, except for a statistically insignificant fraction, the eigenvalues all lie within a finite interval, near the ends of which the behavior of the level density disagrees with what is observed for nuclear levels. On the other hand, the nearest-neighbor spacing distribution corresponds to the Wigner surmise. The results for higher-order spacings are also discussed. (auth)

35044 SIGNIFICANCE OF SHELL CORRECTIONS IN THE PARAMETERIZATION OF NUMERICAL STATE DENSITY CALCULATIONS. Williams, F. C. Jr.; Chan, G.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Nucl. Phys.; A187: No. 2, 225-48(1972).

The nuclear state density of a non-interacting fermion system has been calculated directly from a set of single-particle Nilsson levels both as a function of energy and deformation by two numerical methods. The first method is a combinatorial calculation and is based on the repetitive use of recursion relations to expand the grand partition function. The second is based also on the grand partition function, however, in this method one uses the saddle-point approximation to deduce the relevant thermodynamical quantities. Both methods eliminate the unjustifiable assumption of the conventional theory of level densities that the single-particle level scheme can be represented by a continuous distribution. An approximate relationship between the Strutinsky shell correction and the effective zero of excitation energy extrapolated from the nuclear entropy in a region of high temperature has been demonstrated algebraically. A similar relationship is shown to exist numerically for excitation energies in the 40 to 60 MeV region. However, the entropy intercept depends on the temperature and is not equivalent to the Strutinsky shell correction for a non-uniform set of single-particle levels. In the calculations reported, we emphasize the importance of shell structure on the energy-dependent level density. The results of the calculations show that with a realistic set of single-particle orbitals, one can account qualitatively and in some cases quantitatively for the parameters found necessary to fit experimental data. Calculations reproduce qualitatively the observed values of a_f/a_n found in measurements of the ratio of the fission width to neutron emission width and predict also the important role of the liquid-drop fission saddle-point deformation in the interpretation of medium-energy fission-fragment angular distributions. (auth)

35045 CORE-PARTICLE COUPLED MODEL OF THE EFFECTIVE CHARGE: THEORY AND CALCULATION IN A = 39, 41 NUCLEI. Goode, Philip (Univ. of Rochester, N. Y.); West, Bruce J.; Siegel, Stan. Nucl. Phys.; A187: No. 2, 249-304(1972).

In this paper we describe how effective charges may be calculated within the framework of the full-shell model by means of a core-particle coupling model (CPCM). We consider nuclei with a single particle (hole) outside (inside) a doubly magic core. The nuclear Hamiltonian is obtained from coupling the valence particle (hole) to the eigenstates of the diagonalized core. It is shown how the perturbation theory effective charge formalisms, as given by Brown and Shukla and by Siegel and Zamick, may be obtained from the more complete core-particle coupling formalism via various approximations to the eigenfunctions of the full-shell model matrix. The validity of these approximations is examined, and the formal equivalence of the two perturbation approaches is demonstrated. The formalism of the CPCM as a framework in which to calculate the effective charge, is applied to the single-particle and single-hole nuclei A = 41 and A = 39 with a ^{40}Ca core. The calculation of the TDA (RPA) core states and the valence-particle (hole) effective charges are done using the Kallio–Kolltveit matrix elements, with and without density dependence, as well as the "bare" Kuo–Brown matrix elements. The calculation is also performed, and comparisons made between the full-shell model, restricted shell model and the Siegel–Zamick effective charges, for the three sets of matrix elements. (auth)

35046 EVALUATION OF FISSION BARRIER PARAMETERS FROM NEAR-BARRIER FISSION AND ISOMERIC HALF-LIFE DATA. Weigmann, H.; Theobald, J. P. (EURATOM, Geel, Belgium). Nucl. Phys.; A187: No. 2, 305-13(1972).

A combined analysis of data from narrow intermediate structure in near-barrier fission cross sections and from shape-isomer half-lives has been tried in a very phenomenological model. Among the results, one observes a marked even-odd effect in the $\hbar\omega$ values, while the barrier heights do not show a significant effect of this type. It seems that one of the most important open questions is whether or not narrow intermediate structure exists close to the neutron binding energy in the Cm isotopes. (auth)

35047 ANALYSIS OF REACTIONS WITH POLARIZED DEUTERONS. I. Seiler, F. (Univ., Basel). Nucl. Phys.; A187: No. 2, 379-400(1972).

Criteria have been derived for a simplified analysis of measurements with polarized deuterons. At energies up to several MeV, deuteron reactions with light nuclei show pronounced resonances. In the vicinity of such levels the easily obtainable polarization efficiencies of rank 2 are shown to be the most promising observables for an analysis. The assumption is made that one (l, s, J) matrix element on or near a resonance dominates all others. In this approximation the magnitude and angular dependence of the efficiencies for tensor polarization are characteristic for that element or some of its parameters. Formulas and tabulated calculations are given for the evaluation of experimental data. Measurements available at present are discussed in this context and compared to recent predictions for levels near a threshold. (auth)

35048 MASS NUMBER DEPENDENCE OF THE DIFFRACTION MODEL PARAMETERS. Abul-Magd, A. Y.; Simbel, M. H. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 3: No. 16, 673-5(15 Apr 1972).

The possibility of a mass number dependence of the absorption domain in the diffraction model of deuteron elastic scattering is investigated. Phase shifts for deuteron elastic scattering are calculated using standard optical-model parameters. The resulting partial-wave amplitudes are then approximated in the diffraction model and the parameters extracted. The mass-number dependence of these parameters is discussed. (J.W.R.)

35049 PRE-EQUILIBRIUM PARTICLE EMISSION FROM LIGHT NUCLEI. Gadioli, E. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan). Lett. Nuovo Cim.; 3: No. 12, 515-19(18 Mar 1972).

The energy dependence of the excitation functions for (p,α) reactions with light nuclei is explained using a generalization of the pre-equilibrium emission model. Calculations are performed for several (p,α) reactions using a pre-equilibrium emission model and compared with experimental data. (J.W.R.)

PHYSICS (PLASMA AND THERMONUCLEAR)

Refer also to abstract 34919.

35050 (RISO–250) PROCEEDINGS OF THE 3rd INTERNATIONAL CONFERENCE ON QUIESCENT PLASMAS, ELSINORE, SEPTEMBER 20–24, 1971. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971. 396p. (CONF-710929).

Fifty-one papers are presented and arranged according to the following subjects: Plasma Production, Ion Waves, Electron Waves, Drift Waves, Nonlinear Effects, and Special Topics. An abstract was prepared for each of 44 of the papers. The remaining 7 papers appeared previously in NSA 26: 3042, 3043, 3044, 3045, 3046, 11174, and 19516. (Denmark)

For abstracts of individual papers see: 34331, 34436, 35054, 35055, 35072–35074, 35091, 35092, 35101–35104, 35109, 35110, 35127, 35132–35141, 35153, and 35160–35176.

35051 PLASMA PHYSICS INDEX. VOLUME 7, NO. 3, 1972. Bibliography, Author Index, Subject Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 181p.

This listing contains 617 references on various aspects of the subject above. (M.O.W.)

35052 NUCLEAR FUSION RESEARCH IN JAPAN. Yoshikawa, Masaji (Japan Atomic Energy Research Inst., Tokai). At. Jap.; 15: No. 10, 5-11(Oct 1971).

Nuclear fusion research programs in the past and at present are reviewed, aided with a chart for organizational setup and a list of institutions with their activities. (Japan)

Confinement and Heating

35053 (CTO–808) CONTAINMENT OF AN OHMIC-HEATING PLASMA IN THE URAGAN HIGH-SHEAR STELLARATOR. Vishnevetskii, V. N.; Volkov, E. D.; Dikii, A. G.; Zalkind, V. M.; (and others). Translated by C. R. Brightmore for Culham Lab., Abingdon, Eng., from Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 5, 751-6 (1971). 9p. Dep. NTIS (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 26: 5454. (M.O.W.)

35054 (RISO–250, pp 22-6) MAGNETIC MULTIPOLE CONFINEMENT OF A MAGNETIC FIELD-FREE PLASMA. Limpaecher, Rudolf; MacKenzie, K. R. (California Univ., Los Angeles). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The plasma vacuum chamber is lined with rows of permanent-magnet bars 0.7 cm square, and 3.1 cm long (spaced 0.7 cm apart), which are alternately oriented to provide a mirror cusp field with a maximum strength of about 1600 G at the pole faces, decreasing to the order of 5 G about 3 cm away from the multipole structure. The plasma is produced by electron emission of 1 to 100 mA from a short filament located in the internal field-free region. Densities up to 10^{10} cm^{-3} and 5×10^{10} cm^{-3} are produced in helium and argon respectively at pressures less than 10^{-4} torr, with a uniformity in the field-free internal region of approximately 1%, and a noise level $<\delta n/n \approx 3 \times 10^{-4}$. An identical chamber, with nonmagnetized bars, showed density variations greater than 20% over the same region, and a noise level about 30 times higher. In the afterglow, the contained plasma decayed about 100 times slower than the identical control plasma. T_e could be varied from 2 to 5 eV, making this plasma a very convenient and economical device for wave studies. (auth) (Denmark)

35055 (RISO–250, pp 119-27) ION HEATING CAUSED BY ION ACOUSTIC WAVES IN AN ION-STREAMING PLASMA. Honzawa, T.; Kawai, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

It is experimentally shown that ion heating occurs because of ion-acoustic waves driven by streaming electrons in an ion-streaming plasma characterized by $T_e/T_i \lesssim 1$. The excitation of the waves and the mechanism of ion heating in such a plasma are also discussed. (auth) (Denmark)

35056 CHANGES IN THE SPECTRUM OF BACK-REFLECTED RADIATION IN LASER HEATING OF A PLASMA. Zaritskii, A. R.; Zakharov, S. D.; Kryukov, P. G.; Matveets, Yu. A.; Fedosimov, A. I. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 4, 127-9(20 Feb 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 4, 184-6(20 Feb 1972).

The spectrum of the laser light reflected from a plasma was measured, when targets of LiD, $(CH_2)_n$, $(CD_2)_n$, D_2O ice, and aluminum were used. The source was a mode-locked Nd laser consisting of a driving generator and a six-stage amplifier. The plasma heating and the spectral measurements were performed both at the fundamental and at the second harmonic frequencies. The experiment is described and an examination of the spectrograms showed that the observed process is stimulated. It may be due to phase modulation of the powerful light pulses in the plasma layer. (J.C.W.)

35057 TOROIDAL CONFINEMENT OF HIGH-β PLASMAS IN SCREW-PINCH-LIKE CONFIGURATIONS. Zwicker, H. (Max-Planck-Institut fuer Plasmaphysik, Munich). Atomkernenergie; 19: No. 3, 184-90(May 1972).

The possibilities of toroidal high-β confinement in configurations with toroidal plasma currents are discussed. For circular plasma cross section, such high-β configurations are unstable with respect to helical m = 1 modes. Basic principles of dynamic stabilization for such equilibria are introduced and demonstrated by experimental results. This way, however, implies β values for which the fast compression heating is very ineffective. This disadvantage can be avoided by toroidal configurations, which have a strongly elongated plasma cross section. In this case, a toroidal equilibrium below the Kruskal–Shafranov limit can be obtained also for high β values. The principle is briefly discussed and demonstrated by experimental results. They indicate stable confinement for times of about 100 μs at temperatures of about 50 eV and densities of 0.5 to 1×10^{16} cm^{-3}. The plasma lifetime is here obviously limited by diffusion. It could be, therefore, that the confinement time is strongly increased at higher temperatures. (auth)

35058 HIGH-FREQUENCY PLASMA HEATING IN A STELLARATOR. Burchenko, P. Ya.; Volkov, E. D.; Kramskoi, E. D.; (and others) (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 15: No. 5, 174-6(5 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 5, 250-3(5 Mar 1972).

Preliminary results are reported for hf heating in the Sirius stellarator. The main purpose of the experiment was to ascertain the possibility of supplying hf energy to the plasma with the aid of an exciting system that produces a spatially periodic longitudinal electric field on the periphery of the plasma column. The feasibility of the heating technique is shown. (M.O.W.)

35059 RADIAL PLASMA RESPONSE DURING INTENSE BEAM HEATING. Benford, G. (Univ. of California, Irvine). Phys. Lett.; 39A: No. 3, 247-8(8 May 1972).

Heating by microscopic beam mechanisms proceeds until a longitudinal density gradient cuts off phase coherence between the beam and excited plasma waves. A thin plasma column produces this inhomogeneity by radial transport. The maximum temperatures that result from several different regimes of the beam–plasma instability are found. (auth)

35060 PARTICLE LOSS IN A TOROIDALLY SYMMETRIC CUSP. Levine, Morton A. (Air Force Cambridge Research Labs., Bedford, Mass.); Boozer, Allen H.; Kalman, G.; Bakshi, Pradip. Phys. Rev. Lett.; 28: No. 20, 1323-6(15 May 1972).

It is shown that previous calculations of the loss rate of ions from toroidally symmetric line cusps need substantial revision. The symmetry of the toroid produces a conserved generalized momentum which prevents a certain class of particles from penetrating the mirror-like magnetic fields which exist above the cusp points. The importance of this reduction in loss rate is explained for several geometries, including Tormac, which can now have a loss rate substantially smaller than a mirror device. (auth)

35061 OBSERVATION OF NEOCLASSICAL, INTERMEDIATE, AND PFIRSCH–SCHUELTER DIFFUSION IN THE dc OCTOPOLE. Ohkawa, Tihiro; Gilleland, John R.; Tamano, Teruo (Gulf General Atomic Co., San Diego, Calif.). Contract AT(04-3)-167. Phys. Rev. Lett.; 28: No. 17, 1107-11(24 Apr 1972).

Plasma transport processes were studied in the dc octopole with a toroidal magnetic field. The plasma diffusion is characterized by three principal collision-frequency regimes. The magnitude of the diffusion coefficient shows an inverse-square dependence on the magnetic field in all regimes. In the high-collision-frequency regime, the measured local diffusion coefficient agrees with Pfirsch–Schuelter diffusion in both rotational transform dependence and magnitude. Both for intermediate and low values of collision frequency, the enhancement of the decay rate agrees with neoclassical theory. (auth)

35062 ION HEATING IN A TOKAMAK WITH TRANSIT-TIME MAGNETIC PUMPING. Brambilla, M.; Giuffre, S. (EURATOM-CEA, Grenoble, France). Nucl. Fusion; 12: No. 199-200(Mar 1972).

Starting from the ion energy balance equation for a tokamak including heating by a Transit Time Magnetic Pumping (TTMP), a remarkably simple equation giving the increase of the ion temperature, is obtained, which is largely independent of the nature of the electron energy losses. It is shown that an experiment with TTMP heating on a relatively small tokamak with a sufficiently small aspect ratio can, in principle, allow the transition from the intermediate to the low collision diffusion regime to be reached. (auth)

35063 RADIATION POWER OF A PLASMA AS A FUNCTION OF THE DISCHARGE PARAMETERS IN THE TOKAMAK-3 DEVICE. Gorelik, L. L; Mirnov, S. V.; Nikolaevskii, V. G.; Sinitsyn, V. V. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 12: No. 2, 185-9(Mar 1972).

Results obtained in measuring the radiation power of a plasma under different discharge regimes in a Tokamak-3 device are discussed. Experiments are described in which xenon is added. It is demonstrated that the fraction of energy lost by radiation increases with the plasma density and decreases as the energy input is increased. (auth)

35064 NEUTRAL-BEAM-INJECTION HEATING OF TOROIDAL PLASMAS FOR FUSION RESEARCH. Kelley, G. G. (Oak Ridge National Lab., Tenn.); Morgan, O. B.; Stewart, L. D.; Stirling, W. L.; Forsen, H. K. Nucl. Fusion; 12: No. 2, 169-76(Mar 1972).

Extending the encouraging confinement results in tokamak devices and further establishing scaling laws makes it essential to attain ion temperatures corresponding to the collisionless regime, where reactors will operate. Ohmic heating used in the present devices is self-limiting since the plasma resistance drops as the temperature increases. Neutral-beam injection heating is not only a supplemental heating scheme that is efficient and not self-limiting but is also a developed technology ready for application. Injection heaters have been developed at ORNL for ORMAK which are capable of supplying 60 kW to the plasma per injector with up to four units usable. These systems use 4 A of H^+ and H_2^+ ions at 35 to 40 keV from a duoPIGatron ion source. These heaters are capable of increasing the ion temperatures in the 8×10^5 cm^3 ORMAK plasma volume to several keV at densities of ≈ 3 to 6×10^{13} cm^{-3}. (auth)

35065 SPECIAL TIME-DEPENDENT SOLUTIONS OF DIFFUSIVE TOKAMAK EQUILIBRIUM. Nuehrenberg, J. (New York Univ., N. Y.). Nucl. Fusion; 12: No. 2, 157-63(Mar 1972).

Time-dependent tokamak equilibria are investigated for which the magnetohydrostatic equilibrium equation is satisfied at each instant and the driving terms are due to small but finite scalar resistivity. Explicit solutions are obtained under the following conditions: (a) the standard tokamak expansion is used; (b) the temperature is assumed to be spatially constant within the plasma; (c) the toroidal field is the vacuum field; (d) the time scale is $\epsilon^{-1}t_s$ or $\epsilon^{-2}t_s$, where t_s is the ordinary skin time and ϵ the expansion parameter. The solutions are characterized by a poloidal energy ratio of unity and four time-dependent parameters (the applied toroidal electric and magnetic fields, the ellipticity of the plasma cross section, and the major radius) which are connected by a differential equation in time. An additional time-dependent parameter is the triangularity of the plasma cross section. Two cases are considered with respect to the equation of state, T = const and the adiabatic equation of state. Another way of characterizing the equilibria obtained is in terms of the total energy per length W/R and the total toroidal current I. The scaling $W/R \propto I^2 R^{-2} (a(1-a))^{1/2}$, where R is the major radius and a characterizes the ellipticity, is valid throughout. (auth)

35066 SPECULATIONS ON THE CONFIGURATIONAL PROPERTIES OF A FUSIONING PLASMA. McNally, J. Rand Jr. (Oak Ridge National Lab., Tenn.). Nucl. Fusion; 12: No. 2, 265-6 (Mar 1972).

A system consisting of a proton E-layer in a closed magnetic bottle and a means for axial injection of fusion fuel is discussed. The confinement of plasma by its own configurational properties is discussed. (M.O.W.)

35067 IMPERFECT AXISYMMETRY IN THE TOKAMAK CONFIGURATION. Anderson, O. A. (Univ. of California, Livermore); Furth, H. P. Nucl. Fusion; 12: No. 2, 207-13(Mar 1972).

In real experimental tokamaks, the necessity for access space between toroidal field coils spoils the ideal axisymmetry of the configuration. The "ripple" in toroidal field strength (typically a few percent) causes nonsymmetric trapping of particles; the resultant drift orbits generally lead to the wall. A criterion is given for the avoidance of this particle loss. The TORMAG computer program is used to calculate a sample coil system that preserves experimental access while also meeting the orbit criterion. In present-day tokamaks, the main effect of the excessive toroidal field ripple is the loss of multi-keV ions from the tail of the Maxwellian, an effect that is reflected in the vertical asymmetry of the charge-exchange neutral diagnostic data. In thermonuclear plasmas, loss due to nonaxisymmetry becomes important even for bulk plasma ions. The loss problems for alpha particles and for energetic injected ions (if isotropic) are particularly serious. (auth)

35068 DIFFUSION COEFFICIENT OF PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Popov, I. L. Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 3, 221-3(Mar 1972). (In Ukrainian).

A general expression is obtained for the diffusion coefficient of plasma. Bohm empirically suggested the expression for the diffusion coefficient, which as a special case follows from the general expression. Expression for ionic mobility was obtained. (auth)

35069 LOW-FREQUENCY BEAM–PLASMA INTERACTIONS IN A FINITE-SIZED PLASMA. Bhatnagar, Ved Prakash. Ann Arbor, Mich.; Univ. of Michigan (1971). 274p. University Microfilms Order No. 72-14,806.

Thesis.

This study is concerned with the experimental and theoretical investigation of ion heating via the generation of a large, low-frequency rf electric field in a plasma by a modulated electron beam. The beam-generated plasma is approximately 60 cm in length and 6 mm in diameter. An electron beam with 400 to 1000 V energy and 2 to 3 mA of current is used. Either hydrogen, deuterium, neon, or argon gas is used with pressures in the range of 10^{-4} to 10^{-3} torr. The plasma has a density in the range of 5×10^8 to 5×10^9/cm^3 and a typical electron temperature of 6 eV. The ratio of plasma density to beam density is approximately 25, and an axial magnetic field of 300 to 400 G is used. The ion heating process suggested by the analysis and experiment is that the electron beam excites resonant modes of the plasma-cavity resonator, and that at these resonances a large radial electric field is created in the plasma which excites ion oscillations. The generation of this large rf field at low frequencies results in the observed ion heating. The importance of this result is that the electron beam can transfer energy directly to the plasma ions at frequencies other than those at which there is a strong beam–plasma instability. (TSS) (Diss. Abstr. Int., B)

35070 ELECTROSTATIC FIELD APPARATUS FOR REDUCING LEAKAGE OF PLASMA FROM MAGNETIC TYPE FUSION REACTORS. Hirsch, Robert L. (to International Telephone and Telegraph Corp.). U. S. Patent 3,655,508. 11 Apr 1972. Filed 12 Jun 1968.

This invention relates to a fusion reactor of the magnetic mirror type having a plasma trap defined by relatively widely spaced field lines, and end regions closed substantially by the field lines. Plasma leakage from the trap occurs primarily through the end regions as the plasma particles tend to follow the field lines. Electrostatic reflectors serve to reflect particles that have escaped from the plasma trap via the end regions back along the escape paths, these electrostatic reflectors taking the form of positively and negatively charged field-forming electrodes arranged in tandem such that positively charged plasma particles will be reflected by one electrode and negatively charged particles will be reflected by the other. (auth)

35071 INVESTIGATION OF THE EFFECT OF OBSTACLES ON PLASMA IN THE SPHERATOR. Pacher, Guenther Wolf. Princeton, N. J.; Princeton Univ. (1971). 127p. University Microfilms Order No. 72-14,161.

Thesis.

Obstacle-induced plasma density perturbations and the enhanced loss produced by them were studied in the spherator. This investigation follows the previous observation of a strong dependence of this radial loss on background neutral pressure, a dependence which was explained as the result of support-induced plasma convection. Measurements of the azimuthal loss distribution exhibit maxima near the support locations in the supported spherator SP-3, and probe measurements revealed large density perturbations centered on the field lines passing through the supports. Evidence is presented which establishes a link between these two observations. Further experiments in the levitated version of the spherator examined the variation of depth and width of the depression produced by an obstacle with background neutral pressure. These experiments were performed in the zero-gradient region of the density profile, and their results are compared with those of a fluid model embodying only classical effects. Good agreement was obtained at low neutral pressure. However, the theory predicted a strong variation of the depression with electron temperature at high neutral pressure, which was not observed experimentally. Generally, the experiments reveal only inappreciable variations of depth and width of the depression as the neutral pressure was varied over an order of magnitude, in contrast to the expectations of the convection hypothesis mentioned above. The mechanism of the radial plasma loss therefore remains unexplained, although the great increase in confinement time in the levitated spherator over that of the supported version confirms the identification of obstacles in the plasma as the cause of the enhanced plasma loss. (Diss. Abstr. Int., B)

Diagnostics

Refer also to abstracts 34267 and 34469.

35072 (RISO-250, pp 185-93) WAKE BEHIND AN OBSTACLE IN A SINGLE-ENDED Q MACHINE AND ITS USE AS A DIAGNOSTIC OF THE ION DISTRIBUTION FUNCTION. Schmitt, J. P. M. (Ecole Polytechnique, Paris (France). Laboratoire de Physique des Milieux Ionises). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The wake behind different obstacles immersed in the plasma flow of a single-ended Q machine is investigated. This experiment is shown to be a simulation of the flight of a polar satellite through the ionosphere. The obstacles experimented with (disk, blade, probe) are thick in the streaming direction to ensure their electrical neutrality towards the cesium ions. The measurements agree very well with the theory; in particular, the coupling of the wake with ionic Bernstein modes is demonstrated. The excitation of pseudo waves by means of a small probe is described for frequencies below the ion gyrofrequency. The wave amplitude variations, as a function of space, are compared to the density in the steady wake. This experiment is used as a diagnostic of the ion distribution function; the measurement of the perpendicular ion temperature and of the ion mean velocity are shown to be good. (auth) (Denmark)

35073 (RISO-250, pp 374-81) MEASUREMENT OF $T_{i\perp}$ OF Ba PLASMA IN A Q MACHINE. Katsumata, I. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Ion temperature perpendicular to the magnetic field, electron temperatures, plasma densities, and plasma potentials of Ba plasmas in a single-ended Q machine are measured in a low-density regime by means of an ion-sensitive probe. Data obtained are compared with the predictions of a collisionless theory of Q-machine plasma. Satisfactory agreement is found. In particular, within an experimental accuracy of 10%, the measured ion temperatures agree with the corresponding temperatures of the plasma-generating plate. (auth) (Denmark)

35074 (RISO-250, pp 382-7) SMALL ELECTROSTATIC ENERGY ANALYSER. Michelsen, Poul (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

A small energy analyzer was constructed for measurements of the local ion velocity distribution function in a Q machine. The outer diameter of the analyzer was 2 mm and the collecting area 2 × .5 mm. To avoid cesium condensation, the analyzer can be heated to about 300°C. The analyzer can be used in a double-ended Q machine without disturbing the plasma too much. Measurements of the ion velocity distribution are discussed. (auth) (Denmark)

35075 SCATTERING OF LASER LIGHT BY STATIONARY PLASMA IN CASCADE ARCS. Gieres, G.; Kempkens, H.; Uhlenbusch, J. (Technische Hochschule, Aachen). Atomkernenergie; 19: No. 3, 205-10(May 1972). (In German).

Spectroscopic measurements of electron temperature and density in a wall-stabilized arc at normal pressure are difficult because of the non-LTE population of excited levels. These state variables could be obtained only by solving a system of coupled rate equations. A direct experimental method to determine these variables is using laser scattering. The light of a ruby laser (50 MW) passes through a slit between the cascaded disks and is focused side-on onto the arc axis. The spectral distribution of the scattered light is observed at 90° (scattering parameter $\alpha = 0.84$). The shape of the scattered profile and the total intensity of the scattered light are used to determine the electron temperature and density respectively. The results are in good agreement with spectroscopic data. (auth)

35076 DETERMINATION OF THE TEMPERATURE OF A NITROGEN PLASMA JET FROM THE INTENSITY OF THE BACKGROUND CONTINUUM. Andres, Francoise; Fauchais, Pierre; Baronnet, J. M. (Ecole National Superieure de Mechanique et d'Aerotechnique, Poitiers, France. Univ., Limoges, France). Compt. Rend., Ser. B; 274: No. 7, 467-70(14 Feb 1972). (In French).

The radial distribution of the temperature in a nitrogen plasma jet was determined by measuring the intensity of the background continuum in the 4000- to 8000-A range. (France)

35077 DIAGNOSTIC AGGREGATE CONTAINING A LASER INTERFEROMETER FOR MEASUREMENT OF THE ELECTRON CONCENTRATION IN THE JET OF A STATIONARY PLASMA SOURCE. Malyutin, A. A.; Rybakov, V. V.; Starostin, S. G.; Subbotin, A. K.; Ushanov, S. N. (Moscow Aviation Inst.). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 849-50 (May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 167-8(May-Jun 1971).

A diagnostic complex with a laser interferometer for measuring the electron concentration in the jet of a stationary plasma source by switching it off is described. The use of TsTS-19 piezoceramic in the electronic stabilization system and in the shock-absorbing suspension allows measurement to be carried out under powerful mechanical vibrations caused by the operation of the auxiliary devices. (auth)

35078 HIGH-FREQUENCY ELECTRICAL PROBE IN A PLASMA. Kudryavtsev, A. M.; Fishman, I. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Instrum. Exp. Tech. (USSR) (Engl. Transl.); 14: No. 3, 851-3(May-Jun 1971).

Translated from Prib. Tekh. Eksp.; 14: No. 3, 169-70(May-Jun 1971).

The possibility of using a single electrical probe for measurement of high-frequency (up to 3 GHz) potential oscillations in a low-temperature plasma is considered. It was shown that, in the case of longwave electrostatic potential oscillations, a probe shielded from the plasma by a thin dielectric shield is coupled to the equivalent oscillation generator via the capacitance of the layer next to the probe, which in a number of cases is independent of the plasma parameters. The construction of a probe having satisfactory frequency response in the 0.1- to 3-GHz range is presented. (auth)

35079 LANGMUIR PROBES IN PLASMA WITH ANISOTROPIC VELOCITY DISTRIBUTIONS. Tokutaka, H.; Frood, D. G. (Lakehead Univ., Thunder Bay, Ont.). Can. J. Phys.; 50: No. 4, 410-3(15 Feb 1972).

The electron temperature measured by a flat-plate Langmuir probe in a plasma with an elliptically anisotropic distribution function is shown to be related in a simple manner to the electron temperatures on the principal axes of the distribution function and to the orientation of the plate with respect to these axes. Velocity anisotropy would be most readily measured using the ac modulation technique in conjunction with a rotatable probe. (auth)

35080 MAGNETIC PROBES WITH NANOSECOND RESPONSE TIME FOR PLASMA EXPERIMENTS. Decker, G.; Honca, D. L. (Univ. of Texas, Austin). J. Phys., E (London); 5: No. 5, 481-4 (May 1972).

Small magnetic probes for use in a collisionless shock experiment were constructed. The method of building the coil, connecting it to the oscilloscope, shielding and enclosing the probe, calibration, and testing of the time response with a fast square-wave pulse and a sampling oscilloscope are described. These probes, with response times of ≤2 ns, were used to measure correspondingly fast disturbances in an oblique shock wave. (auth)

35081 UTILIZATION OF THE X-RAY-UV SPECTRA OF MULTIPLY CHARGED IONS IN THE STUDY OF PLASMAS PRO-

DUCED BY THE IMPACT OF A LASER BEAM ON BULK TARGETS. Schwob, J. L. (Centre National de la Recherche Scientifique, Meudon, France); Seka, W.; Breton, C. J. Phys. (Paris), Colloq.; No. 4, 44-7(1971). (In French).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

X-ray and uv spectra emitted by multiply charged Al and C ions were used to study the buildup and expansion of a plasma produced by the incidence of a laser beam on bulk Al and polyethylene targets. It was shown that, in the buildup phase, the plasma produced at different depths within the target has essentially the same characteristic parameters. The solid plasma zone limit consists of a thin layer at high temperature absorbing the laser light, a shock wave being created that is propagated towards the solid, where it produces vaporization. In the expansion phase, it was shown that the highly ionized plasma expands rapidly and recombines until a certain limiting degree of ionization is reached, which remains constant. In the case of Al and C, the last ion corresponding to a closed structure corresponds to a large discontinuity in the ionization potential. The results are in agreement with theoretical calculations made in other laboratories. (France)

35082 STUDY OF A PLASMA BY FAR UV ABSORPTION. Carillon, A.; Jaegle, P.; Dhez, P. (Univ., Paris). J. Phys. (Paris), Colloq.; No. 4, 48-52(1971). (In French).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

The existence of strong absorption in the far uv was established for an ionized Al plasma. The uv source and the absorbing medium (which can be considered as the sample) are both plasmas generated by focusing two beams originating from the same Nd-glass laser onto two Al target surfaces. The spectral analysis is performed using a double concave grating spectrometer, whose entrance and collimator slits isolate the zone of interest (sample). Advantage is taken of the optical delay introduced into the path of the source generating laser beam, which may be used in conjunction with a scintillator and fast response photomultiplier to provide temporal analysis. Examination of the mechanism responsible for the absorption indicates the importance of radiative energy exchanges over collision processes (inverse bremsstrahlung appears to be the main absorption process at the center of the plasma, photoionization becoming significant only at the periphery). Such energy exchanges must therefore be considered in theoretical calculations. (France)

35083 MEASUREMENT OF THE ATOMIC AND IONIC TEMPERATURE OF A PLASMA BY ABSORPTION X-RAY SPECTROSCOPY. Lacaze, M. R.; Bonnelle, C.; Valentin, P. (Univ., Paris. Univ., Rouen). J. Phys. (Paris), Colloq.; No. 4, 57-60(1971). (In French).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

A new method for measuring the temperature of heavy particles in an Ar plasma at atmospheric pressure and in thermal equilibrium is described. Its use can be extended to low-pressure plasma measurements where classical methods are practically impossible. (France)

35084 MEASUREMENT OF THE MAGNETIC-FIELD DIRECTION IN A TOKAMAK PLASMA BY RUBY-LASER LIGHT SCATTERING. Meyer, R. L.; Leclert, G. (Laboratoire de Physique des Milieux Ionises, Nancy). Nucl. Fusion; 12: No. 2, 269-70 (May 1972).

A numerical calculation is performed of the scattered spectrum. Realistic parameters were used; hydrogen plasma density, 10^{19} m^{-3}; electron temperature, 500 eV. A semilog plot of the scattering cross section is given as a function of normalized frequency shift for various angles. (M.O.W.)

35085 THEORY OF ION BOUNDARY LAYERS. Johnson, Ronald A.; de Boer, P. C. T. (Cornell Univ., Ithaca, N. Y.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 5, 664-70 (May 1972).

Theories are presented for the electric boundary layers that form on flat-plate and cylindrical probes aligned parallel with a high speed flow, when the probe potential is large and negative. Both slightly ionized continuum flows and collisionless plasmas are considered. In the former case, the probe potential is supposed sufficiently large to make the electric boundary layer thick compared with the viscous boundary layer. The corrections arising from the presence of the viscous boundary layer are calculated. The cases considered are solved either by an integral method, or by a quasi-one-dimensional method. The results obtained can be used to determine the freestream ion density from the current measured experimentally. A comparison is made between theory and some available experimental data. (auth)

35086 DETERMINATION OF PLASMA ELECTRON-DENSITY DISTRIBUTION FROM THE RESONANT FREQUENCIES OF A PARALLEL-PLATE CAVITY. Eaves, Reuben E. (Electronics Research Center, Cambridge, Mass.); Twardeck, Thomas G.; Morin, Stephen J. IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-19: No. 2, 221-6(Mar 1971).

A microwave resonant cavity method of plasma diagnostics is demonstrated for a parallel-plate cavity containing a cold, collisionless, and isotropic plasma. The method is extended to more general cavities and plasmas in the Appendix. The approach presented here differs from perturbational formulations in that assumptions about the perturbed fields are not made. The analysis gives an exact relation between the electron-density distribution and the resonant frequencies. Laboratory measurements of resonant frequencies then allow a spatially detailed computation of the electron-density distribution. Results are found to agree well with Langmuir probe measurements. (auth)

35087 OPERATION, DIAGNOSTICS, AND SPECTROGRAPHIC ANALYSIS OF A DISC-SHAPED PLASMA FOCUS. Wetzel, Daniel Eugene. Columbus, Ohio; Ohio State Univ. (1971). 123p. University Microfilms Order No. 72-15,322.

Thesis.

An investigation was made of the properties of a dense plasma focus employing disc geometry. The properties examined included; time of focus, duration of focus, minimum focus dimensions, time development of the plasma discharge, correlation of voltage and dI/dt measurements with a photographic history of the plasma discharge, presence and time development of contaminants in the plasma. (TSS) (Diss. Abstr. Int., B)

Kinetics (General)

35088 (AD-734685) CHARACTERISTICS OF AN ARGON FREE JET EXPANDED FROM A HIGH-PRESSURE INDUCTIVE ARC SOURCE. Payne, W. F. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Jul 1971. Contract Nonr-4073(00). 202p. (UTIAS-165). NTIS.

A study was made of the free jet flow field of argon heated by an inductive arc and expanded into a low-density wind tunnel. The objective was to obtain high expansion velocities, and thus arc operating pressures from 0.4 to 1.0 atm were chosen to ensure near-thermodynamic equilibrium of the gas before expansion. (auth) (NTIS)

35089 (CONF-680993) THERMOPHYSICAL PROPERTIES OF A LOW-TEMPERATURE PLASMA. 3rd All-Union Thermophysical Conference on the Properties of Materials at High Temperatures, Baku, September 30-October 5, 1968. Samuilov, E. V. (ed.) (Akademiya Nauk SSSR). 1970. 175p. (In Russian).

Papers are included on theoretical and experimental studies of thermodynamic properties; composition; electric conductivity; and kinetic, gasdynamic, optical, and other properties of a low-temperature plasma. Articles are presented concerning the measurement of the most important parameters of a plasma by spectral, pyrometry, electron-physics, and other methods. Many articles are devoted to development and improvement of ultrahigh-frequency, contact, circuit, and other methods of measuring plasma conductivity. Studies of the operation of devices to obtain a plasma under laboratory conditions in various arc discharges by using an electrodeless discharge, lasers, shock tubes, etc. are presented. (NTIS)

35090 (NP-19271) WILLS PLASMA PHYSICS DEPARTMENT TWENTY-SECOND SIX-MONTHLY PROGRESS REPORT, 1 JULY-31 DECEMBER 1971. (Sydney Univ. (Australia). School of Physics). 10p. (PR-22). Dep. NTIS (U. S. Sales Only).

A brief summary is given of plasma physics work at the Sydney University School of Physics. The particular items discussed are the following: (1) plasma sources, (2) hydromagnetic ionizing fronts, (3) plasma decay, (4) rotating plasmas, (5) cyclotron harmonic waves in SUPPER V, (6) hydromagnetic waves, (7) laser diagnostics, and (8) far infrared. (M.O.W.)

35091 (RISO-250, pp 9-16) STRUCTURE OF AN ALKALI-PLASMA COLUMN IN A WEAK MAGNETIC FIELD. Krumm, P. H.; Hellberg, M. A.; Baker, G. R. (Natal Univ., Durban (South Africa)). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

In the single-ended Q device of the University of Natal Plasma Group, a Cs or K plasma is produced by surface ionization in the density range of 10^{8} to 10^{9} cm^{-3}. A cylindrical plasma column is formed by means of a collimator in front of the tungsten hot plate ($T = 2.3 \times 10^{3}$ K) and diffuses along a weak axial magnetic field

(B = 50 to 900 G). The column structure is investigated by a floating potential method with electrostatic probes for various values of B. In all cases a radial electric field appears at the plasma edge together with a charge separation. Thus the plasma column consists of a quasi-neutral core surrounded by a charge double layer ("sheath") the position of which is independent of the magnetic field strength and is given by the collimator radius. The sheath width however increases with decreasing B. The plasma column is surrounded by a metallic cylinder as boundary which can be earthed or biased, and is limited in the axial direction by a grounded endplate. Measurements of electron and ion fluxes to these boundaries for various values of B together with the comparison of potential, electric field and charge density profiles for both Cs and K plasmas support the view that for low magnetic field strength (B < 1 kG) the structure of the plasma column is determined by the spatial distribution of the electrons to which the ions adjust themselves. This appears to be understandable in the light of the extremely different ion and electron Larmor radii, the ion Larmor radii being of the order as the diameter of the Plasma column. Models to explain the detailed structure are also discussed. (auth) (Denmark)

35092 (RISO–250, pp 63-70) CALCULATIONS AND MEASUREMENTS OF THE PERTURBED DENSITY AND ION VELOCITY DISTRIBUTION FUNCTION IN GRID-EXCITED WAVES IN A Q-MACHINE PLASMA. Christoffersen, G. B.; Jensen, V. O.; Michelsen, P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

On the basis of the linearized quasi-neutral Vlasov equation, the density perturbation n(x,t) and the perturbed ion velocity distribution function f(x,v,t) for ion acoustic waves were calculated. This theory, the results obtained, and experimental measurements that support the theoretical results are reported. (auth) (Denmark)

35093 (UCRL-Trans–10609) SPECTRA OF Sc XIV AND Sc XV EMITTED BY LASER PLASMA IN THE 100 TO 200 A REGION. Boiko, V. A.; Voinov, Yu. P.; Ivashkin, P. I.; Sklizkov, G. V. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Russian Preprint No. 4. 7p. Dep. NTIS.

Measurements and identification of 24 spectral lines between 100 and 200 Å from scandium plasma generated by focusing laser radiation on the surface of a solid target are reported. The transitions identified are $2s^22p^3-2s2p^4$ in Sc XV and $2s^22p^4-2s2p^5$ in Sc XIV. (auth)

35094 CONTINUUM EMISSION OF HIGH-TEMPERATURE PLASMAS IN THE VACUUM ULTRAVIOLET. Bogen, P.; Lie, Y. T.; Rusbueldt, D. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 19: No. 3, 217-20(May 1972).

The continuum emission of a theta pinch in helium or deuterium ($n_e \approx 4 \times 10^{17}$ cm^{-3}, T $\approx 8 \times 10^5$ K) and of a sliding spark through a polyethylene capillary ($n_e \approx 2 \times 10^{19}$ cm^{-3}, T $\approx 4 \times 10^5$ K) was investigated in the wavelength region between 67 and 350 nm. The radiation of the discharges in He, D_2, and CH_2 is expected to be mainly bremsstrahlung of He II, D I, and C IV, respectively, all of them having nearly the same spectral distribution. This is in agreement with the observation, when reabsorption is negligible. Since the spectral distribution of the bremsstrahlung can be calculated accurately, it was possible to use the emitted continua for an intensity calibration. This calibration was used to determine the electron density of a plasma that is optically thick in the visible and near-ultraviolet region by means of an absolute intensity measurement at 73 nm. (auth)

35095 STABILITY OF A HOMOPOLAR DEVICE. Bhat, P. K.; Srivastava, M. P. (Indian Inst. of Science, Bangalore). Indian J. Phys.; 44: No. 12, 625-34(Dec 1970).

A plasma shell of finite thickness and of infinite conductivity is considered to be in steady state in the presence of a space-varying magnetic field such as found in the Ixion device. The instabilities for such a device were studied by the normal mode technique, both for axisymmetric and azimuthal disturbances. It was found that the system is unstable in zeroth order of the perturbation parameter β for an axisymmetric disturbance. Further, the effect of slow rotation and slowly varying magnetic field is to increase the growth rate of instability. The system is unstable in the zeroth order for the azimuthal disturbance. The first-order dispersion relation shows that the effects of low-intensity ring currents is to increase the growth rate of instability. Further, the increase of rotation decreases the growth rate of instability. (auth)

35096 BREAKDOWN BEHAVIOR OF THE INDUCTIVE RING DISCHARGE. Geissler, E. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 19: No. 3, 199-204(May 1972).

The initial development of the electron density during the breakdown phase of an electrodeless inductive discharge which is excited by a pulsed homogeneous periodically oscillating magnetic field was investigated. The experimental conditions were such that no electrostatic fields could penetrate into the discharge tube and that the magnetic field applied reached its full amplitude in the first half cycle of its oscillation. From the observed dependency of the characteristic times on the electric field, the breakdown field strength can be deduced. Appropriate breakdown field strengths were evaluated under various experimental conditions such as nature of the gas, pressure, frequency and tube dimensions. With hydrogen for which most of the data were collected, a similar law could be found empirically. There is strong evidence that the exciting magnetic field causes at least two nonnegligible effects in contrast to the usual theories, which pay attention only to the influence of the electric field. (auth)

35097 ELECTRON SPIN MOTION IN A MAGNETIC MIRROR TRAP. Granger, Sara; Ford, G. W. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett.; 28: No. 22, 1479-82(29 May 1972).

Averaging methods are used to discuss the electron spin motion in a magnetic mirror trap of the sort used in precision g−2 experiments. An expression is obtained for the difference frequency correct up to second order in the field nonuniformity. When applied to the experiments this result removes the discrepancy between the last two precision g−2 measurements and yields a corrected value for the gyromagnetic anomaly: a = (1,159,656.7 ± 3.5) × 10^{-9}. (auth)

35098 SOME EXPERIMENTAL OBSERVATIONS ON CIRCULATING CURRENTS IN A CROSSED-FIELD PLASMA ACCELERATOR. Jedlicka, J.; Haacker, J. (Ames Research Center, Moffett Field, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 5, 563-4(May 1972).

Voltage, current, and magnetic field as well as heat transfer to selected electrode and insulator wall regions were measured in a fully water cooled MHD channel. The channel flow discharged as an open jet into a test chamber that contained a time-of-flight velocity instrument and traversing probes for measuring Pitot pressure, stagnation pressure, and stagnation heat transfer and a probe that gave local velocity and electric conductivity. All data were recorded as functions of time. (M.O.W.)

Kinetics (Experimental)

35099 (AD–709686) INDUCTIVE PULSED PLASMA CURRENT SHEETS. Final Report. Dailey, C. L. (TRW Systems Group, Redondo Beach, Calif.). Jun 1970. Contract F44620-68-C-0042. 53p. (AFOSR–70-1730-TR). NTIS.

A detailed set of probe measurements and a laser light-scattering measurement of electron density were made in the current sheet produced by a pulsed inductive accelerator. The purpose of the investigation was to formulate a physically valid description of the processes within the current sheet. It was found that the discharge consists of a thin flat disc of pure j_θ current having nearly constant properties over the accelerator diameter. The only current carriers are electrons. The gas is ionized and swept up into a 4-mm-thick plasma layer near the center of the current sheet. Ion acceleration is by an axial-charge-separation electric field that is effective ahead of the mass layer only, where it is produced both by electron current and by a strong negative electron pressure gradient. On the accelerator coil side of the mass layer the positive electron gradient is just supported by the current sheet body force and the accelerating electric field nearly vanishes. Both the light-scattering measurement of density and that calculated from probe data show that the plasma is mostly doubly ionized. (auth) (NTIS)

35100 (N–70-31919) MEASURED OPTICAL ABSORPTION COEFFICIENTS FOR URANIUM PLASMAS. Miller, M. H.; Wilkerson, T. D.; Roig, R. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Apr 1970. 51p. (NASA-CR–72661; BN–652). NTIS.

Absolute emissivities of uranium plasmas (3000 to 8800 A) were measured using a gas-driven shock tube. Temperatures (7500 to 12,000 K) and uranium pressures ($^1/_{30}$ to $^1/_3$ atm) approach those anticipated at the hydrogen−uranium interface of proposed gas-core nuclear reactors. At these conditions, U(I), U(II), U(III) is essentially the only spectroscopically active constituent of shock-tube test gases composed of 0.2 to 2.0% UF_6 in neon. Absolute emissivities at 5000 A are measured photoelectrically both in emission and in absorption. The variation of emissivity with wavelength was obtained from time-resolved photographic recordings. Measured visible emissivities are smaller than theoretical predictions, depending on the plasma's state. Emissivity (and opacity) decrease with increasing temperature slightly more rapidly than theory predicts. The dependence of emissivity on uranium density is an order of magnitude greater than expected theoretically. The data suggest that the continuum is more important than previously supposed. Between 4000 to 8800 A, emissivity varies with wavelength in essentially the predicted way; however, a predicted surge in ultraviolet (3000 to 4000 A) emissivities was not observed. (auth) (NTIS)

35101 (RISO–250, pp 17-21) QUIESCENT PLASMA SUSTAINED BY HIGH FREQUENCY FIELDS. Ault, Earl R.; MacKenzie, K. R. (California Univ., Los Angeles). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

A large-volume quiescent laboratory plasma is sustained by alternating voltage of 20 to 80 V rms (at 70 to 100 MHz) applied to an electrode consisting of 0.0025-cm tungsten wires stretched about 1 mm apart across a metal frame 30 cm in diameter. In the plasma a sheath forms around each wire with a thickness which decreases with density. In this sheath the ionizing electrons pick up energy by accelerating past the wire with the correct phase to utilize the transit time effect. (The fraction of electrons lost to the fine wire is small.) Evidence for this mechanism is indicated by the fact that: 1) The electron plasma frequency is considerably higher than the applied frequency; hence the electric fields are confined to the sheath region; and 2) at normal operating voltages there is insufficient ionization to initiate the process. Some other means, such as a momentary discharge from a hot filament, a pulse of photoionization from a spark, or a large increase in pressure, is required to produce the initial plasma and set up the proper sheath conditions around each wire. This process was used to sustain a plasma in argon at $\approx 4 \times 10^{-4}$ torr with a noise level $\langle \delta n/n \rangle \approx 2 \times 10^{-4}$. Densities in the 10^8 to 10^9 range are produced in a volume of 30 liters. Linear ion waves and nonlinear shocks are easily produced in this device. T_e is of the order of 5 eV. (auth) (Denmark)

35102 (RISO–250, pp 33-9) EXPERIMENTAL STUDY OF THE FIRST-ORDER ION DISTRIBUTION FUNCTION RELATED TO IONIC WAVE IN A Q MACHINE. Mills, P. (Ecole Polytechnique, Paris (France). Laboratoire de Physique des Milieux Ionises). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

An experimental study of oscillations of the first-order ion distribution function in an ion wave is proposed, and the possible presence of features related to collective effects is discussed. (auth) (Denmark)

35103 (RISO–250, pp 55-62) MEASUREMENTS OF THE PERTURBED ION VELOCITY DISTRIBUTION AT A WAVE-EXCITING GRID. Christoffersen, G. B. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Theoretical treatment of propagation of ion-acoustic perturbation based on the Vlasov equation necessitates knowledge of g(v), the perturbed ion velocity distribution function at the grid. This knowledge is also important in connection with experimental investigations. In a single-ended Q-machine g(v) is measured with an electrostatic energy analyzer. The measurements show that both the shape and the size of g(v) are drastically changed with the various parameters, particularly the dc grid potential. (auth) (Denmark)

35104 (RISO–250, pp 290-6) MEASUREMENT OF VELOCITY DIFFUSION IN AN ELECTRON BEAM–PLASMA INTERACTION. Barrett, P. J.; Gresillon, D.; Wong, A. Y. (California Univ., Los Angeles. Dept. of Physics). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The interaction between a large-diameter electron beam and a collisionless plasma is investigated experimentally in the absence of a magnetic field. The noise power grows spatially and then decays at the same rate. The beam is simultaneously scattered, forming a monotonically decreasing tail in the distribution function. By means of a lock-in technique, the beam particles are tracked through the interaction and observed to spread to both lower and higher energies; the velocity diffusion coefficient is then determined. (auth) (Denmark)

35105 EXPERIMENTAL STUDY OF TURBULENT RESISTIVITY IN LOW-β PERPENDICULAR MHD SHOCK WAVES. Dippel, K. H.; Hintz, E.; Hoethker, K. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 19: No. 3, 225-31(May 1972).

Perpendicular hydromagnetic shock waves were generated in a theta pinch. Initial densities and magnetic fields were chosen such that $(\omega_{ce}\tau_{ei})_1$ varied between 10 and 100, β_1 between 10^{-1} and 10^{-2}. For Alfvén Mach numbers below the critical, electrical resistivity was the main dissipation mechanism. Predominantly, the electrons were heated. Strongly enhanced resistivity was observed. Measured effective collision frequencies are compared with those predicted by Sagdeev on the basis of ion sound instabilities and by Krall and Liewer for flute-like drift modes. (auth)

35106 ENERGY LOSS OF A LOW-ENERGY ION BEAM IN PASSAGE THROUGH AN EQUILIBRIUM CESIUM PLASMA. Klavan, I. L.; Cox, D. M.; Brown, H. H.; Bederson, B. (New York Univ., N. Y.). Phys. Rev. Lett.; 28: No. 19, 1254-8(8 May 1972).

The energy loss of a beam of cesium ions traversing a near-thermal equilibrium cesium plasma was measured as a function of plasma density at ion-beam energies of 35 to 150 eV. The plasma electron/ion temperature was 2100°K, and the charged-particle density was varied from $(0.1 \text{ to } 3.7) \times 10^{11}$ cm^{-3}. The measured energy loss is found to agree very well with theoretical predictions. (auth)

35107 EXPERIMENTAL EVIDENCE FOR STATIONARY POPULATION INVERSIONS OF ATOMIC LEVELS IN AN EXPANDING HYDROGEN PLASMA. Hoffmann, P.; Bohn, W. L. (Institut fuer Plasmadynamik, Stuttgart). Z. Naturforsch.; 27a; No. 5, 878-80(May 1972). (In German).

Detailed calculations of population densities of excited levels in a decaying hydrogen plasma flow predict population inversions within a definite range of plasma parameters. This was verified experimentally in a rapid expanding plasma where the characteristic time of decay was much shorter than the relaxation time of the ground state. Population inversions were found for the first transitions of the Paschen and Brackett series. (auth)

35108 COMPARISON OF MEASURED AND THEORETICAL INVERSE BREMSSTRAHLUNG AND PHOTOIONIZATION ABSORPTION OF INFRARED RADIATION IN A H–He PLASMA. Billman, Kenneth W.; Stallcop, James R.; Rowley, Paul D.; Presley, Leroy L. (Ames Research Center, Moffett Field, Calif.). Phys. Rev. Lett.; 28: No. 22, 1435-8(29 May 1972).

The absorption coefficients of 1.15- and 3.39-μ radiation for a homogeneous H–He plasma were measured in the temperature range $14 \times 10^3 \leq T \leq 20 \times 10^{3}$°K and electron density range $8 \times 10^{16} \leq n_e \leq 5 \times 10^{17}$ cm^{-3}, where the major absorption mechanisms are electron–ion inverse bremsstrahlung and neutral-atom photoionization. The measured values compare well with those obtained from theoretical calculations for a gas in thermodynamic equilibrium. (auth)

Kinetics (Theoretical)

Refer also to abstracts 34486 and 34508.

35109 (RISO–250, pp 40-7) EXACT CALCULATION OF THE PERTURBED DISTRIBUTION FUNCTIONS ASSOCIATED WITH ELECTROSTATIC WAVES. Buzzi, J. M. (Ecole Polytechnique, Paris (France). Laboratoire de Physique des Milieux Ionises). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

For forced oscillations, the complete calculation of the perturbed distribution function $F_1(x,v,t)$ associated with electrostatic waves is considered, using the classical linear kinetic theory. Analytical expressions give the general properties of $F_1(x,v,t)$. Numerical results for Maxwellian plasmas are presented for ion and electron plasma waves excited by a dipole. (auth) (Denmark)

35110 (RISO–250, pp 365-73) POTENTIAL SURROUNDING A MOVING TEST PARTICLE IN A QUIESCENT PLASMA. Hines, K. C. (Melbourne Univ., Parkville (Australia)). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The self-consistent Vlasov and Maxwell equations can be solved for the effective potential surrounding a test particle in a plasma. The solution is in the form of a 3-dimensional k-space integration. Preliminary results of a numerical evaluation of the potential valid for all values of V and r are presented. The accuracy of these results was in some doubt because of numerical problems, and a new method of numerical analysis was therefore developed which is identical to that of Nishimura. However, the results obtained by the old method agree very well with Nishimura's work. The long-range part of the interaction is found to differ both from the standard Coulomb and from the static Debye forms. Contrary to expectations it appears to be impossible to present the potential in the form $1/r^P$, with any p valid over a worthwhile range of V and r. Attention is drawn to the effect of the new form for the potential on the plasma transport processes, particularly the test particle energy loss problem. The comparison with the gravitational case is also instructive, and an additional term occurs in the self-consistent expression for the potential. (auth) (Denmark)

35111 UNSTEADY FLOWS IN SYSTEMS WITH A DENSE PLASMA CONFINED BY WALLS. Oleinik, A. G. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 3-8(Jan-Feb 1972). (In Russian).

Nonsteady state flow of a dense magnetized plasma with $\beta \gg 1$ was studied where a possibility of heat loss by conduction and radiation existed, and solutions to the problem were found for two limiting cases. The first case involved cooling and heating of the plasma, which represented evolution of the temperature profile with respect to time. In the second case, an auto-model solution was found for the random dependence of the coefficient of thermal conductivity on temperature, pressure, and magnetic field. (tr-auth)

35112 STRONG-PLASMA-TURBULENCE MODEL EQUATIONS. Gratzl, H. (Kernforschungsanlage, Juelich, Ger.). Atomkernenergie; 19: No. 3, 191-2(May 1972).

In a fluid of charged particles as described by the Vlasov equation, a turbulent energy is assumed consisting of electrostatic waves. A resonant interaction of two waves with particles is retained in addition to the linear wave–particle resonance. The resulting kinetic equations are similar to those given by Dupree, but with different arguments in the nonlinear terms. (auth)

35113 CALCULATION OF THE TWO-DIMENSIONAL HEAT FLOW AT TOROIDAL PLASMA INCLUSION. Wynands, A.; Schmitz, G. (Technische Hochschule, Aachen). Atomkernenergie; 19: No. 3, 193-7(May 1972). (In German).

The problem of cooling is of great importance for the inclusion of a plasma in material walls. The heat flow in the plasma and in the stabilizing wall has to be calculated with respect to the geometry and the testing parameters. A numerical method is presented for calculating the two-dimensional distribution of temperature and all other interesting macroscopic quantities in the cooling medium. The method enables the calculation of the influence of form and material of the wall on the thermal and dynamic behavior of a plasma not only in cascaded cylindrical arcs but also in toroidal geometries. In this work, results for a toroidal arc are shown and discussed. (auth)

35114 NONLINEAR CONDUCTIVITY OF A PLASMA TRAVERSED BY A FREQUENCY-MODULATED ELECTROMAGNETIC WAVE. Kahan, Theo (Univ., Paris); Allanche, J. D.; Jancel, Raymond. Compt. Rend., Ser. B; 274: No. 7, 463-6 (14 Feb 1972). (In French).

A method is proposed for calculating the electron current density induced in a weakly ionized plasma by two plane electromagnetic waves, one of them being frequency-modulated. Various nonlinear effects are revealed. (France)

35115 LIGHT SCATTERING BY A HIGHLY CORRELATED PLASMA. Delpech, Jean-Francois; Gauthier, Jean-Claude (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 274: No. 7, 460-2(14 Feb 1972). (In French).

The short-range order of the charged particles in a highly correlated plasma has a strong effect on light scattering. When the scattering wavelength and the distance between the particles are of the same order of magnitude, the Fourier transform of the angular distribution of the scattered light depends strongly on the electron pair distribution function. (France)

35116 TIME-EVOLUTION OPERATOR IN THE SEMICLASSICAL THEORY OF STARK-BROADENING OF HYDROGEN LINES. Pfennig, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). J. Quant. Spectrosc. Radiative Transfer; 12: No. 5, 821-37(May 1972).

In the dipole-only case, the time-evolution operator describing how the quantum state of a hydrogen atom in a plasma will change when a perturbing particle passes can be expressed exactly in terms of elementary functions in a simple way. (auth)

35117 NUMERICAL COMPUTATIONS OF LANDAU AND COLLISIONAL DAMPING OF PLASMA LINES. Niimura, M.; chan, P. W.; Churchill, R. J. (Colorado State Univ., Fort Collins). J. Quant. Spectrosc. Radiative Transfer; 12: No. 5, 989-99(May 1972).

Numerical computations of linewidths and intensities of plasma lines due to Landau and collisional damping of a fully and singly ionized plasma were carried out. They are presented in the form of graphs for a wide range of experimental conditions including those under which these plasma lines were observed by light-scattering techniques from laboratory plasmas. Brief discussions of the theoretical background used in the numerical calculations, together with the approximations, are given. The Coulomb-screening integral function involved in the calculation of collisional damping is computed directly and is compared with the approximate expressions used by other workers. Possible experimental conditions wherein these damping effects may be observed by light-scattering techniques are discussed. (auth)

35118 ELECTRON CORRELATIONS IN THE UNIFIED MODEL FOR STARK BROADENING. Capes, H.; Voslamber, D. (CEN, Fontenay-aux-Roses, France). Phys. Rev., A; 5: No. 6, 2528-36 (Jun 1972).

An improved treatment of electron correlations is presented within the framework of a previously developed unified model for Stark broadening by plasma electrons. This treatment employs the method of the Bogolyubov–Born–Green–Kirkwood–Yvon hierarchy in connection with a closure relation corresponding essentially to the exclusion of simultaneous strong collisions. A line-shape expression is derived for the case that the perturbing electron gas is in thermal equilibrium. This expression depends on the dynamic dielectric constant and on the two-electron correlation function. If the latter is approximated by the linearized Debye–Hueckel expression (low-density case), and if the result is simplified for the vicinity of the line center by using second-order perturbation theory for the atom-perturber interaction, the results of earlier treatments of electron correlations are recovered. (auth)

35119 AVERAGE POTENTIAL IN CROSSED-FIELD PLASMAS. Nikolov, N. A.; Nedeltcheva, D. (Univ., Sofia). Nucl. Fusion; 2: No. 2, 191-2(Mar 1972).

An expression is obtained for the average potential, acting from the side of the high-frequency field on a bounded plasma in a magnetic field, the high-frequency field and the magnetic field being perpendicular. In the absence of a magnetic field, the results obtained are in good agreement with the known ones. (auth)

35120 TOTAL RADIATIVE INTENSITY CALCULATIONS FOR 100 PERCENT H_2 AND 87 PERCENT H_2–13 PERCENT He. Stickford, G. H. Jr. (Jet Propulsion Lab., Pasadena, Calif.). J. Quant. Spectrosc. Radiative Transfer; 12: No. 4, 525-9(Apr 1972).

Isothermal radiative intensity calculations for 100% H_2 and 87% H_2–13% He are presented for temperatures of 10,000 to 25,000°K, density ratios of 10^{-4} to 10^{-1}, and path lengths of 1.0 to 30.0 cm. The actual spectral details of the absorption coefficient were computed for 16,000 points from 240 to 30,000 Å by summing the various line and continuum radiative processes at each point. This method should result in a very accurate calculation of radiative emission, including an accurate accounting for reabsorption due to overlapping lines. (auth)

35121 COLLISION TERMS FOR PLASMAS WITH STRONG CORRELATION. Nambu, M. (Tokyo Univ.). Phys. Lett.; 39A: No. 4, 303-4(22 May 1972).

New collision terms are obtained within the framework that the ternary correlation function is expressed in terms of the products of the single particle and pair correlation functions. It is investigated how the Balescu–Lenard collision terms are modified. (auth)

35122 SIMPLIFIED EXPRESSIONS FOR THE CALCULATION OF THE CONTRIBUTION OF THE HEAVY COMPONENTS TO THE TRANSPORT COEFFICIENTS OF PARTIALLY IONIZED GASES. Capitelli, M. (Univ., Bari, Italy). Z. Naturforsch.; 27a; No. 5, 809-12(May 1972).

Simplified expressions for the calculation of the contribution of the heavy components to the viscosity and to the translational thermal conductivity were tested for pure and mixed plasmas. (auth)

35123 PARTITION FUNCTION OF A TWO-DIMENSIONAL PLASMA. Deutsch, C. (Laboratoire de Physique des Plasmas, Orsay, France); Lavaud, M. Phys. Lett.; 39A: No. 4, 253-4 (22 May 1972).

The stability of the canonical partition function of a two-dimensional classical plasma with respect to condensation phenomena is discussed. (auth)

35124 ANALYTICAL APPROXIMATION TO COLLISIONAL DISTRIBUTIONS IN MIRROR PLASMAS. Holdren, J. P. (Univ. of California, Livermore). Nucl. Fusion; 12: No. 2, 267-9(Mar 1972).

A successive approximation technique is used to obtain accurate expressions for the lowest eigenmode M(u) of the Legendre equation $(1 - u^2)\, d^2M/du^2 - 2u(dM/du) + \lambda M = 0$; $M(u \geqq u_0) = 0$, $M(u) = M(-u)$, and for the eigenvalue λ. A table comparing earlier calculations is given. (M.O.W.)

35125 THEORY OF PLASMA TURBULENCE. Linnebur, Eldon John. Ann Arbor, Mich.; Univ. of Michigan (1971). 230p. University Microfilms Order No. 72-14,925.

Thesis.

A theory of plasma turbulence for an infinite spatially homogeneous plasma situated in a stationary external magnetic field is developed within the Klimontovich formulism. By introducing approximations in the multiple-time correlation functions rather than in the fluctuations, as is conventionally done, a hierarchy of equations is obtained which predicts a different behavior for the system especially in connection with three-wave resonant interactions. An equation for the wave energy (for the three waves resonantly interacting) is obtained which, for a spectrum made up entirely of marginally stable waves, is shown to be a second order Markoffian differential equation rather than a first order equation as obtained by others. The conditions under which a first order equation is obtained are examined and discussed. It is shown that when a first order differential equation is obtained for the plasmon density, this equation always has a possible stationary solution thus eliminating the occurrence of "explosive instabilities" in such systems. (Diss. Abstr. Int., B)

35126 MEASUREMENT OF NITROGEN PLASMA TRANSPORT PROPERTIES. Schreiber, Paul W. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio); Hunter II, Allen M.; Benedetto, Kenneth R. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 10: No. 5, 670-4(May 1972).

The electrical and thermal conductivities and radiant power per unit volume, P_R, of nitrogen are measured at atmospheric pressure between 10,500 and 12,250°K and are compared with the results of other investigators. A probe technique based on the Hall effect is used to determine the plasma electrical conductivity and P_R. In addition, P_R is determined by external optical techniques. A separate measurement technique which is used to determine the vacuum ultraviolet contribution to P_R is described. A correction for self-absorption is applied to the probe measurements of P_R. Thermal conductivity is obtained from an energy balance of the power input and measured loss terms. (auth)

Production

Refer also to abstracts 34234, 34400, 34401, 35081, and 35082.

35127 (RISO–250, pp 27-32) PRODUCTION AND APPLICATION OF A URANIUM PLASMA IN THE Q DEVICE. Hashmi, M.; van der Houven van Oordt, A. J. (Institut fuer Plasmaphyisk, G.m.b.H. Garching (West Germany)). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Uranium plasma was produced in the single-ended operation of the Q-device BARBARA. The density and flux measurements were performed with different Langmuir probes. Preliminary results are presented and discussed. The various applications of such a uranium plasma are also mentioned. (auth) (Denmark)

35128 (UCRL-Trans-10610) OBSERVED X-RAY LINES OF HIGHLY IONIZED IRON IN LASER PLASMA. Aglitskii, E. V.; Boiko, V. A.; Zakharov, S. M.; Sklizkov, G. V.; Fedorov, A. N. Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Kratk. Soobshch. Fiz.; No. 12, 36-40(1971). 7p. Dep. NTIS.

The use of a laser and an x-ray tube for production and diagnostics of a plasma with electron temperature of approximately 1,000 eV is described. A spectrogram was obtained which contained nearly 40 lines of highly ionized Fe in the region 10 to 16 Å. (K.S.W.)

35129 NUCLEAR FUSION BY LASERS. Floux, F. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Oyo Butsuri; 41: No. 2, 102-16(Feb 1972). (In Japanese).

After briefly reviewing the main features of laser-produced plasmas and the problems involved in production of nuclear DD reactions, the fundamental data for heating mechanisms are discussed. The experimental results and heating limitations are then developed. Finally, present and future feasibilities both for lasers and plasma parameters are reviewed. (auth) (Japan)

35130 RADIAL DISTRIBUTION OF CESIUM PLASMA PRODUCED BY RESONANCE ABSORPTION. Yamada, J.; Okuda, T. (Nagoya Univ., Japan). Phys. Lett.; 39A: No. 3, 223-4(8 May 1972).

Radial distribution of Cs plasma produced by the resonance absorption was obtained. The distribution has a minimum at the center of the tube and differs from the one for a discharge plasma. (auth)

35131 ESTIMATION OF SCATTERING CENTER IN A DIVERTOR-TYPE PLASMA SOURCE. Toyama, H.; Kuroda, T.; Horikoshi, G. (Nagoya Univ., Japan). Phys. Lett.; 39A: No. 4, 287-8(22 May 1972).

Numerical calculations of the particle trajectory in a Divertor-type plasma source show that the radius of the scattering center is proportional to $(\text{mass})^{1/4}$. (auth)

Stability

35132 (RISO–250, pp 111-18) TWO-ION-BEAM INSTABILITY IN A Q MACHINE WITH INHOMOGENEOUS B FIELD. Baker, D. R.; Bartoli, C.; Bitter, M. (European Space Research Inst., Frascati (Italy)). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The enhancement of thermal noise and the growth of excited ion acoustic waves are studied in the presence of a two-beam plasma with a high temperature ratio. The two ion beams are created in a single-ended Q machine with a localized neutral Cs cloud, as in the method described by Andersen et al. [Phys. Fluids, 14: 728-36(1971)]. The electrons are heated by 50 to 100 milliwatts of microwave power at the upper-hybrid resonance. An inhomogeneous field (inverse magnetic mirror or nozzle) is used to transfer the perpendicular energy of the electrons into parallel energy. In this configuration it is possible to obtain a temperature ratio (T_e/T_i) between 3 and 10, and a ratio of beam velocity to ion thermal velocity of between 1.5 and 3.0 with various ratios of density between the two beams. (auth) (Denmark)

35133 (RISO–250, pp 169-76) ION-ACOUSTIC INSTABILITY OF A TWO-TEMPERATURE, COLLISIONAL, FULLY-IONIZED PLASMA. Rognlien, T. D.; Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

From a perturbation of the fluid equations for a homogeneous unmagnetized plasma, it is shown that long-wavelength ion waves are unstable when $T_e \gtrsim T_i$. The additional destabilizing effect of a current is also investigated. (auth) (Denmark)

35134 (RISO–250, pp 194-200) CURRENT-DRIVEN COLLISIONAL DRIFT INSTABILITY IN A Q MACHINE PLASMA: WAVE-INDUCED LOSSES AND ANOMALOUS RESISTIVITY. Ellis, R. F.; Motley, R. W. (Princeton Univ., N. J. Plasma Physics Lab.). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Experiments were continued on the current-driven collisional drift instability in a cesium plasma created in a double-ended Q-machine (Plasma Radius = 2 cm, Length = 110 cm, T = 2500°K, $n = 10^{10} - 3 \times 10^{11}$ cm^{-3}). Onset of this large amplitude instability ($\tilde{n}/n_0 \sim 10\%$) is well defined and occurs at a critical current which varies with plasma parameters. Concomitant with onset, the average plasma density decreases by 10 to 30%. These wave-induced losses are consistent with calculations using a linearized two-fluid theory, including electron temperature oscillations and electron heat flow. The calculations employ the measured wave parameters, especially the amplitude and phase of the fluctuating density and fluctuating potential. These results are additional proof that electron temperature oscillations are necessary to describe this instability. Measurements of plasma resistivity indicate that for $n_0 > 10^{11}$ cm^{-3}, where sheath resistance effects are negligible, there is no anomalous plasma resistivity attributable to this mode. (auth) (Denmark)

35135 (RISO–250, pp 201-8) EFFECTS OF PARALLEL WAVELENGTH ON COLLISIONAL DRIFT INSTABILITY. Schlitt, L. G.; Hendel, H. W. (Princeton Univ., N. J. Plasma Physics Lab.). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The dependence of the collisional drift instability on parallel wavelength was studied in potassium Q-machine plasmas. The parallel wavelength is determined by the length of the plasma column ($\lambda_{||} \approx 2L$), which can be varied (L = 15 to 130 cm). The instability is driven by the expansion, limited by resistivity, of the electron fluid parallel to the magnetic field. Stabilization at both long and short parallel wavelength ($\lambda_{||} \gtrsim 200$ and $\lambda_{||} \lesssim 100$ cm, respectively) by ion viscosity was demonstrated. Stabilization of individual modes at high magnetic field and short parallel wavelength ($B/k_{\perp} \approx 1$ kB-cm, $\lambda_{||} \approx 100$ cm) due to ion motion parallel to the magnetic field was also observed. These results are consistent with the predictions of a two-fluid, slab model theory, which includes electron temperature fluctuations in addition to the effects mentioned above. (auth) (Denmark)

35136 (RISO–250, pp 217-23) MEASUREMENTS OF TEMPERATURE WAVES IN CONNECTION WITH A DRIFT-TYPE INSTABILITY. Friz, W.; Mueller, G. L. J.; Palmer, R. S. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Experimental investigations were made to substantiate the existence of electron temperature fluctuations accompanying a drift-type instability in a Q device as predicted in an experimental study by R. W. Motley and R. F. Ellis [Phys. Fluids, 14: 886-9(1971)] and in a theory promoted by S. Tsai, F. W. Perkins and T. H. Stix [Phys. Fluids, 13: 2108-14(1970)]. These fluctuations violate the isothermal assumptions of previous drift-wave theories. It appears their most evident effect is on the phase relations between density and potential fluctuations. Results of measurements and a discussion of the applied diagnostic techniques are presented. The temperature fluctuations are in all measured cases much smaller than the density and potential fluctuations, their normalized value being $2 \times 10^{-2} \leq T/To \leq 7 \times 10^{-2}$. With increasing plasma density the phase lag of the temperature waves increases, whereas their amplitudes decrease monotonically. (auth) (Denmark)

35137 (RISO–250, pp 230-7) PASSIVE FEEDBACK CONTROL OF A DRIFT-TYPE INSTABILITY IN A Q MACHINE PLASMA COLUMN. Mueller, G. L. J.; Palmer, R. S. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

A passive feedback instability control method, consisting of a tunable series resonance circuit connected with a feedback probe and driven by the plasma instability energy itself, was applied to an m = 1, "drift-type" instability of a single ended Q-machine plasma. Phase and amplitude of the feedback drive current is controlled by varying the resonance circuit characteristics. Measurements were made of the oscillation amplification, partial suppression, and the equilibrium plasma losses. The passive control mechanism can be described by the stationary solution of the "Van der Pol" differential equation for nonlinear oscillation phenomena. The efficiency of the oscillation control was found to be small in this experiment because only a single feedback loop is applied. Suggestions are discussed to improve the stabilization efficiency of this passive feedback method. (auth) (Denmark)

35138 (RISO–250, pp 238-45) EXPERIMENTAL FREQUENCIES AND GROWTH RATES OF A DRIFT-DISSIPATIVE INSTABILITY IN A CONTINUOUS rf PLASMA. Keen, B. E.; Alcock, M. W. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Results are presented for a low-frequency self-excited oscillation in an inhomogeneous rf collisional plasma. These waves occurred mainly as m = +1 azimuthal propagation modes and as standing waves in the axial direction with approximately half a wavelength in the tube. The frequency was dependent on the tube length, the axial magnetic field, and the gas neutral pressure, and measurements were made when varying these parameters. The initial growth rates were measured under various conditions, by using a method of dynamic stabilization to suppress the instability, and analyzing the subsequent return of the oscillation. Comparison of the results obtained with a previous theory of the drift-dissipative instability shows reasonable good agreement. (auth) (Denmark)

35139 (RISO–250, pp 297-303) CROSS-FIELD CURRENT-DRIVEN ION ACOUSTIC INSTABILITY. Barrett, P. J.; Fried, B. D.; Kennel, C. F.; Taylor, R. J. (California Univ., Los Angeles. Dept. of Physics); Sellen, J. M. (TRW Systems, Redondo Beach, Calif.). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The instability occurs when ion beam (along x) travels across a weak magnetic field B_z in a plasma with (i) beam velocity v_D greater than the ion acoustic velocity c_s, (ii) $\omega \ll \omega_{ce}$ and (iii) $1 \gg k_z/k_x \gg (m/M)^{1/2}$; the spatial growth rate k_i/k_r is enhanced by a factor k_x/k_z over the value at $B_z = 0$. Measurements of k_i/k_r in two different plasma configurations show good agreement with computed values when $(k_x/k_z)(m/M)^{1/2}(v_D/c_s)$ is assumed to be ~1. (auth) (Denmark)

35140 (RISO–250, pp 334-40) TRAPPED-ION INSTABILITY IN ION-ACOUSTIC WAVES. Ikezi, H.; Kiwamoto, Y. (Nagoya Univ. (Japan). Inst. of Plasma Physics); Mima, K.; Nishikawa, K. (Kyoto Univ. (Japan)). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The growth of the sideband waves was observed when a relatively large-amplitude ion-acoustic wave ($\tilde{n}/n_0 = 0.02 \sim 0.05$) propagates in a collisionless plasma. The structure of the frequency spectrum, growth rate, and the conditions for the instability are consistent with the theory for trapped-ion instability. (auth) (Denmark)

35141 (RISO–250, pp 341-8) MEASUREMENTS ON AN ION SOUND DECAY INSTABILITY INDUCED BY A LARGE AMPLITUDE BERNSTEIN MODE IN A PLASMA. Keen, B. E.; Fletcher, W. H. W. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Experimental results are presented which show that a large-amplitude wave of one of the Bernstein modes, above a certain threshold power, can decay into another Bernstein mode plus a low frequency ion-sound wave. At larger incident amplitudes, a whole spectrum of low-frequency ion waves was observed, with frequencies extending up to the ion plasma frequency (ω_i). These results are compared with a previous theory and reasonable agreement is achieved. (auth) (Denmark)

35142 NATURE OF THE INSTABILITY CAUSED BY ELECTRONS TRAPPED BY AN ELECTRON PLASMA WAVE. Franklin, R. N.; Hamberger, S. M.; Ikezi, H.; Lampis, G.; Smith, G. J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Rev. Lett.; 28: No. 17, 1114-17(24 Apr 1972).

The sidebands which accompany a large-amplitude electron wave on a plasma column are shown to arise from selectively amplified noise; the amplification mechanism is a parametric coupling between the sideband frequencies and the oscillations of the electrons trapped in the large wave. (auth)

35143 ELECTRON-BEAM FILAMENTATION IN STRONG MAGNETIC FIELDS. Benford, Gregory (Univ. of California, Irvine). Phys. Rev. Lett.; 28: No. 19, 1242-4(8 May 1972).

Intense electron beams that are partially current-neutralized can be unstable to transverse modes that form small pinch structures. Beams guided by strong B_z fields experience a circular particle drift at frequency ω_b^2/ω_c, which proves highly destabilizing for filamentary modes. Growth rates considerably exceed the resistive diffusion rates normal for a resistive instability. The mode may be difficult to distinguish experimentally from interchange, but the computed growth rates are in qualitative agreement with present experiments. (auth)

35144 LOCALIZATION OF TRAPPED-PARTICLE INSTABILITIES. Briggs, R. J.; Lau, Y. Y. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 28: No. 19, 1248-51(8 May 1972).

By considering the evolution of an initially localized disturbance, it is shown that collisionless trapped-particle modes in a tokamak geometry remain highly localized in the radial direction up to the point of nonlinear saturation. The inferred localization dimension of only a few "banana" widths is considerably less than the normal-mode picture has indicated. The implications of these results on estimates of the turbulent diffusion coefficient are discussed. (auth)

35145 PLASMA STABILIZATION BY A HIGH-FREQUENCY ROTATIONAL FIELD. Demirkhanov, R. A.; Gutkin, T. I.; Kursanov, Yu. V.; Guvin, Yu. N.; Malykh, L. Ya. (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion; 12: No. 2, 151-6(Mar 1972).

The boundary of a plasma column in a strong, constant, inhomogeneous magnetic field and a high-frequency (hf) E-wave field was studied. An azimuthal current is produced in the plasma by the hf field. The direction of the azimuthal current depends on the direction of the constant, longitudinal magnetic field H_Z. In all cases, however, this current causes the longitudinal magnetic field in the plasma to increase (paramagnetic effect). Stabilization is produced through compensation of the polarization currents by paramagnetic currents due to the hf fields. The behavior of the plasma column in a magnetic field of mirror-trap configuration was investigated experimentally. The high-frequency field was a rotating dipole, homogeneous along the constant magnetic field. The direction of the angular velocity vector for the hf field coincided with the direction of the constant field. The studies showed that the behavior of a plasma in a magnetic mirror trap depends largely on the curvature of the lines of force of the constant magnetic field. In the pinched regime, when the column-formation process has been completed, the level of the observed fluctuations increases with increasing curvature of the mirror-trap field. Tongue-shaped plasma streams are produced at the surface of the plasma column, perpendicular to the magnetic field. The "tongue" rotates in a direction which matches the rotation direction of the constant magnetic field. The frequency of the "tongue" rotation is in the range of 100 to 300 kHz. In addition to the intense deformation corresponding to the m = 1 mode, there are also other modes of higher orders. It is shown that the centrifugal effects caused by plasma rotation contribute to the instability. To control the rotation effect, use was made of a constant magnetic field of octupole configuration, which behaved in the same way as a high-frequency magnetic field rotating in the direction opposite to the plasma rotation. The experimental results provide sufficiently convincing evidence of the possibility of stabilizing convective-type instabilities arising in a plasma. (auth)

35146 CONTRIBUTION TO THE THEORY OF HYDRODYNAMIC PLASMA STABILITY IN THE FIELD OF A FINITE-AMPLITUDE ALFVEN WAVE. Elfimov, A. G.; Nekrasov, F. M. (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion; 12: No. 2, 201-6(Mar 1972).

Decay instabilities for a plasma with $\beta \gg 1$ are considered, and the growth rate and widths of the instability zones are found. The problem of determining the critical wave amplitude is discussed. The solution as a whole was reached for two types of Alfvén waves— standing and traveling. An instability associated with the scattering of the Alfvén wave was found in the second approximation with respect to the parameter h_0/H_0 (h_0 being the amplitude of the Alfvén wave and H_0 the intensity of the constant magnetic field). The excitation conditions for this instability are less stringent than those for decay instabilities. Problems connected with the buildup of instabilities of the type under consideration in systems bounded along the magnetic field are discussed. (auth)

35147 CLASS OF PLASMA EQUILIBRIUM CONFIGURATIONS WITH POSSIBLE APPLICATIONS. Infeld, E. (Inst. of Nuclear Research, Warsaw). Nucl. Fusion; 12: No. 2, 165-7 (Mar 1972).

A generalization of a class of plasma equilibria found by the author is given. It seems to indicate the possibility of a magnetically contained focus, in which an external magnetic field plays an important role in containing the plasma. Another possible application could be to a ball-lightning model. (auth)

35148 FEEDBACK EXPERIMENTS ON A HIGH-ENERGY PLASMA IN THE PHOENIX MIRROR MACHINE. Chuyanov, V. A.; Murphy, E. G. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion; 12: No. 2, 177-84(Mar 1972).

Experiments using a single feedback loop, in which electrostatic signals from a plasma were amplified and fed back as potentials to the plasma boundary, were carried out in the PHOENIX-II mirror machine working as a simple mirror. The effect of the feedback system on plasma losses caused by the flute instability was studied and a correlation between plasma losses and the amplitude and frequency of the instability was obtained. It is concluded that plasma losses can be controlled, to a certain extent, by a simple feedback system. (auth)

35149 ANALYSIS OF RELAXATION PROCESSES AND STABILITY OF A PLASMA IN A UNIFORM ELECTRIC FIELD. Spight, Carl. Princeton, N. J.; Princeton Univ. (1971). 135p. University Microfilms Order No. 72-14,167.

Thesis.

An analytic and numerical investigation was made of the relaxation processes of current driven ion-acoustic wave instabilities in plasmas in an uniform electric field. A review of the work of previous authors on this problem is given in which it is shown that they consistently improperly treated the temporal evolution of the ion distribution function and were thereby led to inaccurate estimates of the characteristics of the quasi-steady state the system exhibits. It is shown that a proper treatment of this problem must recognize the inherent multiple time-scale nature of the evolution of this system. The analysis uncovers three important time-scales for this system after an initial stage in which the ion-acoustic waves are destabilized by the relative electron–ion drift velocity produced by the action of the applied electric field: the electron–ion collisional time scale on which the ion-acoustic wave spectrum grows in magnitude and widens in k-space to effectively limit the drift to that necessary for marginal stability of the waves; an intermediate time scale, the reciprocal of the geometric mean of the Landau-damping decrement and an enhanced collision frequency associated with the waves, on which the detailed balance of the last stages of the first time-scale is achieved; and the ion–ion collisional time-scale, the time-scale for the deposition of resonant ion energy and momentum acquired by linear ion Landau-damping into nonresonant ions. (TSS) (Diss. Abstr. Int., B)

35150 NONLINEAR EFFECTS OF TRAPPED-PARTICLE INSTABILITIES IN TOROIDAL CONFIGURATIONS. Jablon, Claude J. Princeton, N. J.; Princeton Univ. (1971). 155p. University Microfilms Order No. 72-14,150.

Thesis.

A study was made of the trapped-particle instabilities that can be excited in Tokamak configurations at a frequency lower than the ion bounce frequency. A review is given of the linear theory of the collisionless and the collisional modes, using the finite banana thickness to study their radial localization. Ion detrapping induced by a pulsation of the aspect ratio is then proposed for the dynamical stabilization of the collisional mode. By the use of the method of characteristics coupled to a study of the particle dynamics in the presence of fluctuations, the analysis then considers nonlinear saturation of these instabilities: nonlinear ion detrapping saturates the mode at a level of fluctuating potential much smaller than ϵT_i (where ϵ is the inverse aspect ratio and T_i the ion temperature); nonlinear cross-field diffusion is found to be the leading saturation mechanism of the collisionless mode. The resulting turbulent diffusion coefficients are estimated by using standard formulas and compared to the neoclassical diffusion and to other nonlinear estimates. (Diss. Abstr. Int., B)

35151 EXTERNAL FEEDBACK STABILIZATION OF A PLASMA UNSTABLE TO THE INTERCHANGE MODE. Prater, Ronald. Madison, Wis.; Univ. of Wisconsin (1972). 204p. University Microfilms Order No. 72-11,257.

Thesis.

A theory is presented which describes the low-β interchange mode in plasmas in mirror or toroidal multipole magnetic fields. A term proportional to the interchange perturbation density is added to the electron continuity equation to simulate external current feedback. The resulting dispersion relation provides a feedback gain and phase for which the plasma boundary is stable. The instability growth rate and frequency and the feedback phase and gain experimentally required to stabilize the interchange in a multipole-mirror field are in good agreement with the theoretical values. It appears that even a large growth-rate mode ($\gamma_0 \sim 0.2\omega_0$) can be suppressed by external feedback in the form of an electron sink (probe) or source (electron gun) without large disturbance to the equilibrium. Upon interchange suppression, the centerline density increases by 15%. The same theory is also applicable to the problem of line-tying stabilization. In this case, the linearized boundary conditions determine longitudinal currents that can be included in the continuity equation. The dispersion relation then shows that for large growth rates or small sheath admittance at the end plate, line-tying currents can be destabilizing. Direct observation of this effect is obtained, using a segmented conducting end plate and using a feedback suppression technique to measure the growth rate directly. Good quantitative agreement is obtained. Nonlinear amplitude saturation mechanisms are discussed. The dominant saturation mechanism appears to be wave induced change in the equilibrium pressure gradient. (Diss. Abstr. Int., B)

Thermonuclear Processes

35152 (ORNL-TM-3701) INVESTIGATION OF THE TEMPERATURE DISTRIBUTION IN THE LITHIUM BLANKET OF A FUSION REACTOR. Leverette, S. J. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 67p. Dep. NTIS.

A numerical study was made of the effects of a strong magnetic field on the heat-transfer capabilities of flowing liquid lithium in the blanket of a tokamak fusion reactor. The temperature distributions in the blanket were calculated for a series of idealized cases assuming zero eddy diffusivity so that all heat transfer is by conduction. The results show that lithium is suitable as a coolant from the viewpoint of heat-transfer and heat-transport requirements even with slow velocities and thick passages for a vacuum-wall power loading of around 1 MW/m^2. The feasibility of using higher-power loadings depends on magnetohydrodynamic-pumping power requirements and thermal-stress problems. Calculations were made for a proposed experiment to study these effects and check the analysis in a closed lithium loop. (auth)

35153 (RISO-250, pp 1-8) HELIOS PROGRAM. Robertson, Harry S. (Miami Univ., Coral Gables, Fla.). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

HELIOS (for Heated Lithium Ion System) is a nearly completed facility for quiescent, steady-state plasma studies. Lithium ions are injected through two rhenium ionizing nozzles into a 2- to -1 mirror field with four internal Ioffe bars. Electrons are heated by octave-band microwave noise over the electron gyrofrequency range, and ions are heated by wide-band noise around the ion gyrofrequencies. The boundaries of the plasma are formed by a cage of iron wires, each floating electrically and free to assume its own potential. The system is designed to minimize instabilities by eliminating, insofar as possible, all free-energy sources such as currents and temperature gradients. The stochastic heating is also helpful in suppressing certain instabilities, and the boundary cage not only prevents the naturally present plasma potential differences from producing currents via the vacuum chamber walls, but also the local ripples in the magnetic field contribute to containment. Initial experiments in the partially completed system produced plasmas with electron temperature of 35 eV, at densities of $10^{11}/cm^3$ using 200 watts of microwave power. (auth) (Denmark)

35154 (WASH-1206) FUSION REACTOR FIRST WALL MATERIALS. Summary of a Meeting Held at AEC (Germantown), January 27-28, 1972. Ianniello, L. C. (comp. and ed.) (Atomic Energy Commission, Washington, D. C.). Apr 1972. 124p. (CONF-720112). Dep. NTIS.

This report presents the results of a meeting held to examine the scope of problems and priorities in first-wall materials for fusion reactors. A number of problem areas were reviewed together with their relationship to both quasi-steady-state and pulsed reactor confinement schemes of the toroidal and mirror types. Uncertainties in design and a paucity of specific data made an exact assessment of priorities difficult. Nevertheless, a meaningful discussion was possible based on information available from other programs. Among the more important areas discussed were wall erosion, wall compatibility with the coolant, wall integrity from the standpoint of radiation-induced swelling and embrittlement due to gas and defect accumulation, and hydrogen and tritium effects. More research and development will be needed on refractory alloys. Additionally, the pulsed-type system requires insulator development. No obvious fundamental deterrents to fusion reactor development were noted. (auth)

35155 PROGRESS IN NUCLEAR FUSION RESEARCH. Pease, R. S. (United Kingdom Atomic Energy Authority, Culham, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 2, 165-82 (Apr 1972).

Recent scientific advances in controlled nuclear fusion are reviewed. Systematic experiments provided data to advance the understanding of high-temperature plasma physics: studies on magnetic field effects on light scattering, nonlinear effects, and the Bohm diffusion of plasma across magnetic fields are taken as examples. The theory of magnetic confinement is outlined and main results of studies on a number of confinement geometries, including the thetatron system, cusp geometry, magnetic mirror, closed line systems, toroidal pinch discharges, stellarators, and dense plasma systems are presented. Details of the design of a reference toroidal fusion reactor based on the $D(T,n)\alpha$ reaction are summarised. The neutron environment for fusion is compared with that for fission, and preliminary cost estimates are outlined for electricity from fusion reactors. (34 references) (UK)

35156 FAST-PINCH EXPERIMENTS IN THE U.K. 1956-1972. Bodin, H. A. B. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Atomkernenergie; 19: No. 3, 175-83 (May 1972).

This article reviews research in fast-pinch experiments in the U.K., carried out in the Atomic Energy Authority from 1956 to 1972. The first studies of this kind were of high-power linear z pinches carried out between 1956 and 1958 at A.W.R.E., Aldermaston. Theta-pinch research began at A.W.R.E. in 1958 and transferred to Culham Laboratory in the early 1960's. Plasma focus, a variant of the z pinch, has been studied since 1966. Recently the emphasis has moved to toroidal pinches and the large high-beta toroidal experiment has been operational since 1970. (auth)

35157 FUSION REACTORS. Brandt, B. (FOM-Instituut voor Plasma Fysica, Jutphaas, Netherlands). Atoomenergie Haar Toepass.; 14: 59-67(Mar 1972). (In Dutch).

Nuclear reactors fusing hydrogen isotopes into helium promise clean, safe and economical energy by the end of the century. Steady progress in plasma physics is one prerequisite. Reactor problems demand a new technology. (auth) (Netherlands)

35158 MULTIPLE-APERTURE EXTRACTOR DESIGN FOR PRODUCING INTENSE ION AND NEUTRAL BEAMS. Cooper, W. S.; Berkner, K. H.; Pyle, R. V. (Univ. of California, Berkeley). Nucl. Fusion; 12: No. 2, 263-5(Mar 1972).

Four single-aperture extractors are described that differed from one another only in the diameter of the counterbored hole in the beam-forming electrode. The extractors were used to extract ions from a deuterium plasma produced by a hollow-cathode arc discharge. A table rating the extractor performance is given. (M.O.W.)

35159 TOKAMAK DEVICES. Artsimovich, L. A. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 12: No. 2, 215-52 (Mar 1972).

This survey deals with research on plasma in toroidal systems with strong longitudinal fields (Tokamak devices). The movement of single particles in these systems is considered, and the theoretical work on equilibrium, transport coefficients and plasma stability are reviewed. The design of the various Tokamak devices is described, as are the methods of plasma diagnostics employed with them. The main experimental results are summarized and compared with theory. Possible methods of heating plasma are considered and the prospects of the Tokamak program discussed. (auth)

Wave Phenomena

35160 (RISO-250, pp 48-54) NUMERICAL STUDIES OF ION ACOUSTIC WAVE PROPAGATION IN THE NON-MAXWELLIAN PLASMA OF A SINGLE ENDED Q DEVICE. Buzzi, J. M. (Ecole Polytechnique, Paris (France). Laboratoire de Physique des Milieux Ionises). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The experimental ion distribution function found in Q machines by an entire function is presented, and the dispersion curves of this analytical model are compared to the one obtained by a drifted Maxwellian. The plasma response is then calculated, using two other models that may be applied to the case of experimentally measured distribution functions. The first model uses Hermite polynomials, the second is derived from the "Water-Bag". The results of these two models are compared to the analytical solution, and the respective advantages and inconveniences of the two models given. (auth) (Denmark)

35161 (RISO-250, pp 71-8) SIMULATION OF PSEUDOWAVES AND ION ACOUSTIC WAVES. Estabrook, K.; Alexeff, I. (Oak Ridge National Lab., Tenn.). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The time evolution of the ion distribution is numerically calculated from the ion Vlasov and Poisson equations for oscillating negative potentials applied to a grid. The electron density model is exp $(e\phi/kT_e)$. It is found that pseudowaves dominate the ion acoustic waves for frequencies greater than f_{pi} and grid potential less than $-T_i$. For frequency .25 f_{pi}, temperature ratio $T_e/T_i \gg 1$, and maximum potential $-kT_e/e$, the ion acoustic waves marginally dominate the pseudowaves. (auth) (Denmark)

35162 (RISO-250, pp 79-86) EXCITATION OF ION-ACOUSTIC WAVES BY PARAMETRIC HEATING AND STRONG HIGH-FREQUENCY FIELDS. Abrams, R. H. Jr.; Ohe, T.; Lashinsky, H. (Maryland Univ., College Park). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Parametric excitation of ion-acoustic waves was demonstrated in the bounded plasma column in a single-ended Q machine. The electron temperature is controlled by radio-frequency heating and is varied periodically by amplitude modulation of the radio-frequency power at a modulation frequency equal to twice the frequency of the ion-acoustic wave, causing the ion-acoustic velocity to be modulated at this same frequency. The experimental results are in agreement with an analysis based on the Mathieu equation and the linear ion-acoustic damping can be directly related to the threshold value of the modulation index. Similar results are obtained with microwave heating of the electrons. Parametric excitation provides a convenient method for the excitation of ion-acoustic waves for experimental purposes and can also be used in diagnostic applications. (auth) (Denmark)

35163 (RISO-250, pp 87-94) COLLECTIVE INTERACTION AND FREELY STREAMING IONS IN DENSITY PERTURBATIONS AND WAVES IN Q MACHINES. Jensen, V. O. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

The propagation properties of grid-excited density perturbations and ion waves in single-ended Q machines are calculated from the linearized Vlasov equation. The calculations are exact as they take into account the dielectric properties of the plasma as well as the ion velocity distribution in the density perturbation at the grid. The results are compared with the approximate ones obtained in a normal Landau treatment in which only dielectric properties are considered. The effect of collective interaction compared with that of freely streaming ions is discussed. (auth) (Denmark)

35164 (RISO–250, pp 95-102) PROPAGATION PROPERTIES OF SHORT DENSITY PERTURBATIONS IN Q MACHINE PLASMAS WITH DOUBLE-HUMPED ION VELOCITY DISTRIBUTION FUNCTIONS. Twomey, Dennis (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

In a single-ended Q machine, the propagation of ion density perturbations through a plasma with a "double-humped" ion velocity distribution may be treated by a Green-function technique, provided the distribution does not lead to growing solutions. A series of curves are calculated, and some effects due to Landau damping and free streaming are shown. (auth) (Denmark)

35165 (RISO–250, pp 103-10) PROPAGATION OF ION-ACOUSTIC WAVES IN PLASMA WITH DOUBLE-HUMPED ION VELOCITY DISTRIBUTION FUNCTION. Michelsen, P.; Prahm, L. P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

It is possible to form a double-humped ion velocity distribution function in a Q machine. Under certain circumstances such a plasma is "Landau unstable". Propagation of grid-excited stable and unstable ion-acoustic waves is calculated by solving the one-dimensional linearized Vlasov equation as a boundary-value problem. (auth) (Denmark)

35166 (RISO–250, pp 128-35) ION-WAVE EXCITATION VIA A MODULATED ELECTRON BEAM. Buzzi, J. M.; Doucet, H. J. (Ecole Polytechnique, Paris (France). Laboratoire de Physique des Milieux Ionises); Jones, W. D. (South Florida Univ., Tampa). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Results are reported of a preliminary study of a new technique for generating ion acoustic waves in a simple, predictable, and controlled manner with very small voltage perturbation to the plasma in the excitation region. Experimentally, this technique uses a tenuous modulated beam of energetic electrons to produce in the plasma a small volume in which the ion density is periodically increased above the equilibrium plasma density at the modulation frequency of the beam. Theoretically, a model is used that introduces a production (or loss—by grid collector, for example) term in the Vlasov equation. The excitation properties of the modulated beam were compared with those of a grid. In good agreement with experimental observations, the amplitude of the perturbed electron current to a small probe, for example, is predicted to be almost independent of frequency (for $f \ll f_{pi}$) for the beam excitation but to decrease linearly with frequency for grid excitation. Also, in good agreement with theory, the beam excitation is found to produce negligible direct coupling in comparison with that produced by grid excitation. (auth) (Denmark)

35167 (RISO–250, pp 136-43) ION-ACOUSTIC COLLISIONLESS SHOCKS IN A Q MACHINE. Vanek, V.; Marshall, T. C. (Columbia Univ., New York). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Ion-acoustic shocks have been observed in a single-ended Q device, operating at low plasma density, subsequent to microwave heating of the electrons. The microwave source, tuned to electron gyroresonance, can increase the electron/ion temperature ratio to ~13 without ionization. The shock is produced by electrically gating a fine-mesh grid immersed in the plasma; the initial downstream/upstream density ratio is ~7. A step discontinuity in density is observed first to broaden, then to steepen into a shock having Mach number ~1.5 (referred to the ion-acoustic wave speed of the unperturbed plasma). The shock width is less than 10% of the ion–ion collisional mean free path. No shock is formed for $1 \lesssim T_e/T_i \lesssim 5$, as theory predicts. The experimental results can be correlated with ion-acoustic shock numerical simulations. (auth) (Denmark)

35168 (RISO–250, pp 144-50) OBSERVATION OF THE PROPAGATION AND DAMPING OF SMALL AMPLITUDE ELECTRON AND ION WAVES IN THERMALLY IONIZED COLLISIONLESS ALKALI METAL PLASMA. Franklin, R. N.; Hamberger, S. M.; Lampis, G.; Smith, G. J. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Experimental data are presented on the dispersion of small-amplitude electrostatic waves propagating in low-density, magnetized, collisionless, sodium plasma produced by surface ionization on hot tungsten. From such measurements the electron and ion number densities, and the electron temperature were determined, and information on the ion distribution function in a single-ended Q machine was obtained. (auth) (Denmark)

35169 (RISO–250, pp 161-8) ION-ACOUSTIC RESONANCES IN BOUNDED PLASMAS AND COMPARISON WITH REFINED FLUID THEORY. Weynants, R. R.; Messiaen, A. M.; Vandenplas, P. E. (Ecole Royale Militaire, Brussels (Belgium). Laboratoire de Physique des Plasmas). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Measurements on ion-acoustic resonances in cylindrical plasmas are reported. The results allow the identification of the noise components in a number of previous experiments. This furthermore increases the body experimental evidence which can be compared with the theoretical predictions of the refined fluid model which takes nonneutrality into account in the neighborhood of the transonic region. (auth) (Denmark)

35170 (RISO–250, pp 254-60) EXPERIMENTAL MEASUREMENT OF DRIFT WAVES IN A STRONGLY SHEARED MAGNETIC FIELD. Stott, P. E.; Burt, J. (United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Collisionless drift waves were studied in a column of thermally ionized lithium plasma with a variable shear magnetic field. When the shear is zero or weak, the drift waves are unstable and have typical peak amplitudes $\tilde{n}/n_0 \simeq 0.1$. The measured cross-field diffusion coefficient is comparable to D_{Bohm} and is approximately three orders of magnitude larger than the value calculated for classical collisional diffusion. As the shear is increased in magnitude, the drift waves are stabilized and the diffusion coefficient is reduced by two orders of magnitude. (auth) (Denmark)

35171 (RISO–250, pp 267-74) INTERPRETATION OF DISPERSION RELATIONS FOR BOUNDED SYSTEMS. Rognlien, T. D.; Self, S. A. (Stanford Univ., Calif. Inst. for Plasma Research). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

A treatment is given of the problem of constructing normal modes for an arbitrarily bounded system from roots of the linear dispersion relation $D(\omega,\underset{\sim}{k}) = 0$ for the corresponding infinite or periodically bounded system. The implications of the results for the interpretation of experiments on plasma waves and instabilities on finite cylinders are discussed, with particular reference to the effects of endplate damping on collisional drift waves in Q machines. (auth) (Denmark)

35172 (RISO–250, pp 285-9) WAVE GROWTH IN A LARGE UNMAGNETIZED ELECTRON BEAM–PLASMA SYSTEM. Barrett, P. J.; Gresillon, D.; Wong, A. Y. (California Univ., Los Angeles. Dept. of Physics). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

A large-diameter electron beam is drawn into a quiet, collisionless, unmagnetized discharge plasma from a similar plasma. The relative beam density can be varied from 0 to 1 and the beam energy is typically in the range 3 to 10 T_e. When the beam is modulated at frequencies comparable to the electron plasma frequency, growing waves are observed, from which the dispersion is obtained and compared with linear kinetic theory. (auth) (Denmark)

35173 (RISO–250, pp 317-26) EXCHANGE OF ENERGY BETWEEN LARGE-AMPLITUDE PLASMA WAVES AND THE ELECTRON ENERGY DISTRIBUTION. Barbian, E. P.; Jurgens, B. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Instituut voor Atoom en Molecuulfysica). Oct 1971.
From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

Particles trapped in a large-amplitude electrostatic wave cause the growth of sidebands next to the excitation frequency. The displacement of the sidebands starts from a threshold value for the electric field and is proportional to the square root of the large wave amplitude. If instead of one large monochromatic wave, two waves with a small frequency difference are excited, the sidebands become broadened and show a discrete structure. (auth) (Denmark)

35174 (RISO–250, pp 327-33) TEST WAVE AMPLIFICATION AND INSTABILITY CAUSED BY ELECTRON TRAPPING. Franklin, R. N.; Hamberger, S. M.; Ikezi, H.; Lampis, G.; Smith, G. J.

(United Kingdom Atomic Energy Authority, Abingdon (England). Culham Lab.). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

When the electric field of an electron plasma wave is sufficiently large, electrons are trapped by, and oscillate in, the potential wells of the wave. It is shown that sidebands to the main wave are produced by a resonance between the trapped electrons and small-amplitude electron waves propagating in the plasma (e.g., as noise or as a test wave). The frequency differences between the large-amplitude wave and the sidebands are shown to be consistent with the theory. The growth rates of the sideband and of a test wave are shown to be the same. (auth) (Denmark)

35175 (RISO-250, pp 349-56) OBSERVATIONS OF NONLINEAR SCATTERING FROM A PLASMA COLUMN. Bruce, R. L.; Crawford, F. W.; Harker, K. J. (Stanford Univ., Calif. Inst. for Plasma Research). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

An analysis of nonlinear mixing for signals propagating as exp $j(\omega_{\alpha,\beta}t - k_{\alpha,\beta}x)$, incident on an unmagnetized cold plasma column oriented along the z-axis, shows that if only quasistatic dipolar fields are considered in the vicinity of the column, the nonlinearly generated component at $\omega_\gamma (= \omega_\alpha + \omega_\beta)$ has a quadrupolar radiation pattern with maxima at $\pm \pi/4$ and $\pm 3\pi/4$ to the x-axis. The interaction when the quasistatic approximation is not made is considered, and it is concluded that the nonlinearly generated quadrupole component should be accompanied by an appreciable dipole component oriented with its maxima at $\pm \pi/2$. Experiments of previous workers, and the present preliminary observations show strong nonlinear forward scattering, however. In the experiments reported here, this spurious result was traced to the effect of the Earth's magnetic field. When this is cancelled, predominantly quadrupolar radiation is observed, in agreement with theory. (auth) (Denmark)

35176 (RISO-250, pp 357-64) ACQUISITION AND PROCESSING OF PLASMA FLUCTUATION DATA USING FFT SPECTRAL ANALYSIS TECHNIQUES. Smith, D. E.; Powers, E. J.; Rowberg, R. E. (Texas Univ., Austin). Oct 1971.

From third international conference on quiescent plasmas; Elsinore, Denmark (20 Sep 1971).

An analog-digital spectral analysis system for studying plasma fluctuation data is described. The data are initially reduced on a 7-channel, 1.5-MHz, analog, instrumentation-type tape recorder and later digitized for subsequent analysis on a general-purpose computer. The computer output consists of plots of auto- and cross-power spectra, and coherence spectra. An application of spectral analysis to studies of plasma-wave behavior in a noisy or turbulent-like plasma is described. (auth) (Denmark)

35177 SPONTANEOUS EXCITATION OF ION PLASMA OSCILLATIONS. Yamagiwa, Keiichiro (Shizuoka Univ., Japan). Rep. Fac. Sci., Shizuoka Univ.; 6: 29-39(Dec 1971).

The excitation mechanism of the spontaneous ion plasma oscillations was studied in a plasma-beam system produced by a hot-cathode, mercury vapor discharge. The measurement of the energy distribution of the electrons in the plasma-beam system showed that the electrons were roughly classified into three groups: medium electrons with the Maxwellian distribution; primary-beam electrons with relatively narrow distribution at high energy; and drift electrons with the broad distribution. The amplitudes of the ion plasma oscillations were markedly dependent on the energy distribution, and when the width of the velocity distribution of the drift electrons was comparable with the drift velocity, the amplitudes became larger. The excitation mechanism can be explained by the theory of K. Matsuura et al. (auth) (Japan)

35178 EFFECT OF SPATIAL DISPERSION ON STABILITY OF PLASMA LONGITUDINAL OSCILLATIONS. Demchenko, V. V.; El-Naggar, I. A. (Atomic Energy Establishment, Cairo). Phys. Lett.; 39A: No. 3, 205-6(8 May 1972).

It was demonstrated that the allowance for plasma spatial dispersion leads to the instability of harmonic and subharmonic nonlinear longitudinal plasma oscillations. (auth)

35179 LOW-FREQUENCY GRID EXCITATION IN A MAGNETIZED PLASMA COLUMN. Jahns, Gary; Van Hoven, Gerard (Univ. of California, Irvine). Phys. Rev., A; 5: No. 6, 2622-4 (Jun 1972).

Low-frequency signals on a grid in a cylindrical plasma column excite both ion acoustic and guided electron plasma waves. Experiments are described which show that the latter provide the dominant asymptotic response. Measurements of phase velocities and excitation levels are consistent with theoretical predictions. (auth)

35180 SCATTERING OF ELECTROMAGNETIC PULSE WAVES BY CONDUCTING WEDGE IN UNIAXIALLY ANISOTROPIC PLASMA. Hongo, Kohei (Shizuoka Univ., Hamamatsu, Japan). IEEE (Inst. Elec. Electron. Eng.), Trans. Antennas Propagation; AP-19: No. 5, 708-10(Sep 1971).

Asymptotic expansion for the transient response of radiation fields due to electric dipole located above the conducting wedge with an aribtrary angle embedded in a simple plasma is derived by using the saddle-point method of integration. The transient time, which is defined as the time required to reach steady state, is discussed for various kinds of wedge angles and plasma frequencies. (auth)

35181 CHARACTERISTICS OF NORMAL IONIZING SHOCK WAVES IN HELIUM. Bighel, L.; Watson-Munro, C. N. (Univ. of Sydney). Nucl. Fusion; 12: No. 2, 193-7(Mar 1972).

A normal ionizing shock wave is one that propagates, with its shock front perpendicular to a steady magnetic field, into a neutral gas producing ionization. In the experiments described, a cylindrical shock tube of length 170 cm and diameter 21.4 cm was used to study shock velocities and such post-shock parameters as electric fields, densities, and temperatures in helium. Over a range of steady magnetic fields from 3 to 12 kG, discharge currents from 10 to 140 kA and gas pressures of 50, 100, and 200 mtorr, it was found that the shock velocities and electric fields behind the shock agree well with those theoretically predicted from the conservation equations and a modified form of the Chapman-Jouget hypothesis. In these calculations it was assumed that the Saha equation was applicable to the plasma. Spectroscopic measurements of the density and temperature shock profiles were also made, and are compared with those obtained from Thomson scattering. (auth)

35182 EXCITATION OF OSCILLATIONS IN A COAXIAL RESONATOR BY A RELATIVISTIC BEAM OF ROTATING ELECTRONS. Sinitsa, N. G. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: No. 8, 1311-19(Aug 1971). (In Russian).

An excitation of oscillations by a relativistic electron beam in a coaxial resonator is considered. The electrons move along the resonator and rotate with chaotically distributed initial phases in a static magnetic field. (auth)

35183 NEGATIVE PRESSURE EFFECT ON LOW-FREQUENCY WAVES. Nambu, M. (Tokyo Univ.). Phys. Lett.; 39A: No. 4, 347-8(22 May 1972).

Without macroscopic current, the electrostatic low frequency waves grow with the electron's negative pressure effect. The instability mechanism is similar, if not completely analogous, to the Jeans instability in stellar dynamics. (auth)

35184 NUMERICAL SIMULATION OF PLASMA-WAVE ECHOES WITH THE DISTRIBUTION-PUSHING ALGORITHM. Brackbill, Jeremiah Uhler. Madison, Wis.; Univ. of Wisconsin (1972). 234p. University Microfilms Order No. 72-11,230. Thesis.

A direct method for the numerical solution of Vlasov's equation, the distribution pusher, was used to simulate temporal plasma wave echoes in a one-dimensional plasma with electrostatic fields. A thorough analysis of the properties of the distribution pusher is given, including the derivation of its dispersion relation and an analysis of the errors in its solutions of several linear problems. It is found that the grid alias coupling induced instabilities which occur with particle simulation methods do not occur with the distribution pusher, but that the limited velocity resolution of the discrete computation mesh limits the time a simulation may be continued meaningfully. Among the results of a simulation of small-amplitude echoes was found not only the ordinary echo, which occurs at the difference wave number after the application of a time-delayed second pulse, but also a "virtual" echo, which occurs virtually before the application of the second pulse at the sum wave number. The damped tail of the virtual echo should be experimentally observable provided the lifetime of the primary response to the first pulse is of the order of the pulse separation time. Comparison between two runs, which differ only in that one includes self-consistent fields and the other does not, indicates the principal effect of interactions is to broaden ballistic echoes. Simulations of large-amplitude echoes give results that no previously existing theory predicts. However, when one treats the external fields to all orders and the self-consistent fields linearly, a theory is obtained that agrees with simulation results. The numerical method was extended to simulate ion wave echoes by changing the force calculation, and collisional effects by adding a linearized Fokker-Planck operator to the Vlasov equation. The results agreed with theory within computational error. The results obtained demonstrate that the distribution pushing algorithm is a useful aid in performing the analysis of plasma phenomena for which the Vlasov equation is appropriate. (Diss. Abstr. Int., B)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 33382, 33447, 33449, 33789, 34469, 34919, 35265, 35278, and 35372.

35185 (CONF-720503-2) MATHEMATICAL PROCEDURES FOR ESTIMATING DOSE FROM AN INTERNALLY DEPOSITED EMITTER. Snyder, Walter S. (Oak Ridge National Lab., Tenn.). [nd]. 17p. Dep. NTIS.

From second European Congress on radiation protection; Budapest, Hungary (3 May 1972).

The estimate of dose delivered by a radionuclide will depend on its decay scheme and the related dosimetry data available, on its distribution and retention in the body, and on the characteristics of the individual who incorporates the activity. Dillman and Blichert–Toft have provided decay scheme data for most radionuclides, and Spiers has greatly advanced our knowledge of the dose to red bone marrow and to endosteal cells. The new point kernel of Berger offers the possibility of better dosimetry for beta-like radiation. Finally, the methods presented in MIRD Pamphlet Nos. 3, 5, and 8 have made it possible to take account of dose delivered by sources of photons anywhere within the body. The impact of the new ICRP lung model and of identification of endosteal cells as the sensitive cells of bone demands more detailed information on retention and distribution of a radionuclide and its daughters if the corresponding doses are to be computed. The model of Marshall for the metabolism of the alkaline earths (Health Physics, in press) is a first step in this direction, providing estimates of the material present in trabecular and cortical bone. Finally, attention is being given to the importance of individual characteristics (of fetus, infant, child, adult), both as regards uptake and retention (Lloyd et al., Nature 220, 1029, 1968) and with respect to dosimetry (W. S. Snyder, ORNL-4720), although there is an abundance of problems centering about the fetus and younger age groups which will challenge our ingenuity in the future. (auth)

35186 (INR–1370) RANGE AND STOPPING-POWER TABLES FOR PROTONS AND TRITONS IN HELIUM AND ALPHA PARTICLES AND LITHIUM IONS IN BF_3. Zych, Wlodzimierz (Institute of Nuclear Research, Warsaw (Poland)). 1971. 20p. (In Polish). Dep. NTIS (U. S. Sales Only).

Range and stopping-power tables for protons and tritons in helium and alpha particles and lithium ions in BF_3 are given for charged particles of energy 0.1 to 10 MeV. The tables are based on the published data and calculations are extrapolated into regions where data do not exist. (auth)

35187 (STI/PUB–286) BIOPHYSICAL ASPECTS OF RADIATION QUALITY. Proceedings Series. Proceedings of a Symposium Held in Lucas Heights, Australia, 8–12 March 1971. (International Atomic Energy Agency, Vienna (Austria)). Sep 1971. 570p. (In several languages). (CONF-710314). IAEA $15.00.

Thirty-nine papers are included; a separate abstract was prepared for each of 38 papers. An abstract of the remaining paper appeared in NSA Vol. 25 : 55317. (D.E.B.)

For abstracts of individual papers see: 33165, 33446–33449, 33579, 33580, 33606–33612, 33628–33632, 33743–33747, 33781, 33787–33789, 33801, 33802, 33822, 33823, and 35204–35209.

35188 CHARACTERISTIC ELECTRON ENERGY LOSSES IN THIN BISMUTH FILMS. Gauthe, B.; Wehenkel, C. (Paris Univ., Orsay, France). Phys. Lett.; 39A: No. 3, 171-2(8 May 1972).

Several lines in the characteristic energy loss spectra of Bi, some of them unknown, were observed for the first time by transmission through sufficiently thin films; the effect of thickness is established and some tentative interpretations are suggested. (auth)

35189 GAMMA-RADIATION DOSIMETRY FOR ARBITRARY SOURCE AND TARGET GEOMETRY. Hubbard, Lincoln B. (Oak Ridge National Lab., Tenn. Furman Univ., Greenville, S. C.). Comput. Phys. Commun.; 2: No. 7, 449-54(Dec 1971).

The program DOSE1 calculates the first collision dose in the formalism of absorbed fractions for gamma rays in arbitrary finite geometry of source, absorber, and target. The basic unit of the program is a subroutine that calculates the attenuation term $\exp\,[-\int_{r_1}^{r_2}\mu(r)\,dr]$, where μ is the linear absorption coefficient and the line integral is taken along the straight line path from r_1 to r_2. This attenuation term is applicable to all examples of exponential absorption in an arbitrary absorption distribution provided that μ is known as a function of position. This method is exact in principle for only the first collision dose; for bodies whose linear dimensions are much less than the mean free photon path, this is a reasonable approximation. The program, written in FORTRAN IV for the IBM 360/75 and 91, requires 25,500 32-bit words of storage. Execution time varies approximately as $N^{4/3}$, where N is the number of elementary subvolumes. Compilation time is $2\frac{1}{2}$ s on the 360/91, while execution for a simple problem requires 0.2 s. (test run output) (R.W.R.)

35190 ENERGY-LOSS STRAGGLING OF HEAVY CHARGED PARTICLES. Clarkson, R. G. (Los Alamos Scientific Lab., N. Mex. Max-Planck-Institut fuer Kernphysik, Heidelberg. Univ. of Oregon, Eugene); Jarmie, Nelson. Comput. Phys. Commun.; 2: No. 7, 433-42(Dec 1971).

The program STRAGL calculates the energy-loss distribution (straggling) of a monoenergetic beam of charged particles, heavier than electrons, after it has passed through a thin absorber. The energy-loss distribution is calculated by using the formulas of Vavilov with the effects of bound electrons included. This calculation extends and corrects the older regions of the Landau distribution and the Gaussian straggling distribution. If not supplied, the mean ionization potential is calculated by the program. Output includes the mean energy loss, most probable energy loss, and fwhm of the energy distribution. The distribution is plotted, and the values of the distribution in probability per unit energy are tabulated versus the energy loss. The low-energy and absorber-thickness limits are determined by the restriction that the mean energy loss should not be more than 10 to 20% of the initial particle energy. The calculation also fails for very thin absorbers (which cause a few keV energy loss). The program, written in FORTRAN IV for the CDC 6600, requires 44,500 60-bit words of storage. On the 6600 compilation time is about 5 s and typical execution time is about 10 s. (test run output) (R.W.R.)

35191 CHARGE DEPENDENCE OF IONIZATION ENERGY LOSS FOR RELATIVISTIC HEAVY NUCLEI. Eby, P. B.; gan, S. H. Jr. (Marshall Space Flight Center, Huntsville, Ala.). Phys. Rev., A; 5: No. 6, 2536-41(Jun 1972).

The ionization energy loss of relativistic heavy nuclei is calculated using the exact Mott cross section for close collisions. Deviations from the Bloch formula are computed in some typical cases and found to be significant for nuclei with $Z \gtrsim 20$. (auth)

35192 SURFACE DENSITIES AND CURRENTS IN HALF-SPACE TRANSPORT PROBLEMS. McCormick, N. J. (Univ. of Washington, Seattle); Kuscer, I. Transp. Theory Statist. Phys.; 1: No. 1, 1-4(Jan 1971).

Simple expressions are derived for the surface density and net current in time-independent one-speed transport problems for a semi-infinite medium with anisotropic scattering. (auth)

35193 ENERGY-DEPENDENT TRANSMISSION AND REFLECTION IN THIN SLABS. Larson, H. A.; McCormick, N. J. (Univ. of Washington, Seattle). Transp. Theory Statist. Phys.; 1: No. 1, 5-23(Jan 1971).

The energy- and angle-dependent reflection and transmission distributions for the slab albedo problem are obtained for scattering described by a separable kernel. These solutions follow by relating the solution of the nonlinear, invariant imbedding integral equations to the endpoint values of an inhomogeneous, linear, Fredholm integral equation. Use of a stochastic description also permits determination of the mean number of collisions suffered by a particle before it emerges from a face of the slab. Numerical results are obtained for neutrons incident upon a free gas. (29 references) (auth)

35194 CALCULATED BREMSSTRAHLUNG SPECTRA FROM THICK TUNGSTEN TARGETS. Storm, Ellery (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., A; 5: No. 6, 2328-38(Jun 1972).

The bremsstrahlung energy distribution from a thick tungsten target is calculated from the Sommerfeld and Born-approximation thin-target formulas, taking into account electron energy losses, electron backscatter losses, and photon attenuation in the target. Overall agreement with measurement is 20% in the 12- to 100-keV energy range, increasing to 50% at 300 keV. Semiempirical expressions are developed that give 20% overall agreement with measurement in the 12- to 300-keV energy range. (auth)

35195 BREMSSTRAHLUNG CROSS-SECTION FORMULA INCLUDING A HIGH-ORDER COULOMB CORRECTION. Roche, G.; Ducos, C.; Proriol, J. (Univ., Clermont-Ferrand, France). Phys. Rev., A; 5: No. 6, 2403-8(Jun 1972).

A new expression of the differential cross section of bremsstrahlung in nuclear fields is given. Higher-order Coulomb correction terms are included, but the effect of the atomic electron screening, the radiative corrections, and the nucleus size are neglected. Validity of the formula obtained here is discussed. It is expected to give good accuracy in the energy region from a few MeV to about 50 MeV for high values of the atomic number of the target, as long as the screening effects are negligible. Some remarks concerning computation of the cross section are included. (auth)

35196 DEFINITION AND USE OF GREY OPACITIES IN RADIATIVE TRANSFER PROBLEMS. Pomraning, G. C. (Science Applications, Inc., La Jolla, Calif.). Transp. Theory Statist. Phys.; 1: No. 1, 25-40(Jan 1971).

The general problem of reducing a frequency-dependent radiative transfer problem to an equivalent grey problem is discussed. In particular, an asymptotic solution to be used in forming grey opacities is constructed from the integral transport equation. How the angular dependence of this asymptotic result can be incorporated into the grey equation without introducing an angularly dependent opacity is shown also. One needs only to modify the scattering kernel. The resulting grey equation is shown to be exact in the two limiting cases of optically thin and thick systems, where it is well known that the Planck and Rosseland means, respectively, are the appropriate averages. As an example of these considerations, the results are applied to the Elsasser band, and generalizations to non-zero temperature gradients of the Planck and Rosseland means are calculated. (auth)

35197 AUTOMATIC ANALYSIS OF EMPIRICALLY DERIVED LET SPECTRA. Grant III, Walter H.; Oliver, George D. Jr.; Mitchell, Baker A. Jr. (Univ. of Texas, Houston). Health Phys.; 22: No. 4, 351-4(Apr 1972).

An automatic process for unfolding Linear Energy Transfer data is described. The code, ANALET, is written in Fortran IV and handles as many as 2500 data points from segmented data in an objective manner. Point selection, data smoothing and jointing of segments are accomplished reproducibly with only basic information from punched paper tape output from a multichannel pulse height analyzer. Graphic output in event-size formulation, P(Y) vs. Y, may be requested. Dose information is provided in the numeric and graphic form of L · D(L) vs. L. (auth)

35198 DETERMINATION OF LET-SPECTRA FOR GAMMA-NEUTRON RADIATION WITH LOW-EFFICIENCY COUNTERS. Keyrim-Markus, I. B.; Popov, V. I. (Inst. of Biophysics, Moscow). Health Phys.; 22: No. 4, 333-40(Apr 1972).

A method is presented for measuring LET-spectra of gamma-neutron radiation using sets of tissue-equivalent low-efficiency Geiger–Muller counters. Some theoretical principles of the method, mathematical technique of data processing, and parameters of the counters used are summarized. Results of the measurements of LET-spectra for x-, γ- and neutron radiations on the surface of a human phantom and in air are presented. Results are compared with available data of calculations and experiments. (auth)

35199 CHANGES IN THE CHARACTERISTIC-ENERGY-LOSS SPECTRUM OF MOLYBDENUM DURING OXIDATION OF THE MOLYBDENUM SURFACE. Zashkvara, V. V.; Kolot, V. Ya.; Red'kin, V. S.; (and others) (Inst. for Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2836-9 (May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3376-80(Nov 1971).

Characteristic-energy-loss spectra of molybdenum were obtained during oxidation of the molybdenum surface at an oxygen pressure of 5×10^{-6} torr and at a sample temperature of 950°C by reflecting primary beams of electrons having energies of 270 eV and 1 keV through 39°. Secondary ion-ion emission was used under similar conditions to obtain information about the chemical composition and formation kinetics of the oxide layer on the molybdenum surface. These results furnish an explanation for the changes observed in the energy-loss spectra. (auth)

35200 PHONONS IN METAL FILMS AND FAST-ELECTRON ENERGY LOSS IN THE PHONON SPECTRAL RANGE. Heinrichs, J. (Univ., Liege). Phys. Rev., B; 5: No. 12, 4775-92(15 Jun 1972).

The phonons in a metal film and their excitation by fast charged particles normally transmitted through the film are studied within the framework of a classical dielectric theory. The bulk phonons are described by means of the jellium model, which treats the ions as a continuum plasma and the conduction electrons in the Thomas–Fermi screening approximation. The dispersion relation of the surface modes is obtained from the matching boundary conditions that must be satisfied by the solutions of Maxwell's equations. Two kinds of modes connected with surface effects were found; they are distinguished by the nature of the fields they induce inside the film. First, there is a true-surface-mode branch, which exists only at short wavelengths. Second, a family of modes, which carry oscillatory fields in the direction perpendicular to the film and which are called surface-bulk modes because of their mixed character, were found. The energy loss experienced by fast electrons through the excitation of phonons is divided as usual into a bulk energy loss and various surface energy losses, all of which are studied analytically in detail. The effective bulk-loss intensity in a film remains significantly larger than the surface losses, even for very thin films. This indicates that the bulk phonons interact almost as strongly with electrons in thin films as in thick films, which contrasts with the case of plasmons where the effective bulk energy loss vanishes for sufficiently thin films. The predicted bulk energy loss due to phonons should be observable in sufficiently thick metal films with available experimental techniques. On the other hand, since the surface losses would be much enhanced for specularly reflected electrons at grazing-angle incidence they might become observable under such conditions. (auth)

35201 EFFECT OF A METAL CONTACT ON SURFACE PHONONS AND ON ELECTRON ENERGY LOSSES IN DIELECTRIC FILMS. Heinrichs, J. (Univ., Liege). Phys. Rev., B; 5: No. 12, 4792-4802(15 Jun 1972).

A dielectric film bounded by a semi-infinite metal on one side and by a vacuum on the other side is considered. The effect of the electronic screening, due to the free electrons in the metal, on the surface optical-phonon modes in the dielectric film is analyzed and the energy loss experienced by fast electrons in passing through such a film is calculated. The dielectric is represented by the usual continuum-model frequency-dependent dielectric constant including the bulk phonons, and the free electrons in the metal are treated within the Thomas–Fermi approximation. Whereas the high-frequency surface mode is not much affected by the presence of the metal, except at long wavelengths, the low-frequency mode experiences a drastic relaxation up to wavelengths of the order of the Thomas–Fermi screening length. These effects are accompanied by a strong enhancement of the interaction of electrons with the high-frequency surface mode, in most of its frequency range, and a similarly strong reduction of the interaction with the low-frequency mode. As a result, the energy loss of fast electrons due to the excitation of the high-frequency mode is redistributed over the frequency range covered by this mode, in such a way that the intensity is lowered very close to the LO-phonon frequency and strongly enhanced at lower frequencies down to the limiting surface-mode frequency of the unperturbed film. On the other hand, the energy loss associated with the excitation of the low-frequency surface mode is negligible in this case. Numerical results for typical cases indicate that the predicted effects should be experimentally observable. (auth)

35202 ENERGY STRAGGLING OF PROTONS IN ALUMINUM. Nann, H.; Schaefer, W. (Univ., Frankfurt am Main). Nucl. Instrum. Methods; 100: No. 2, 217-19(1972).

The energy straggling of protons in aluminum was measured as a function of the foil thickness in the range from 40 to 120 μm at incident energies between 8 and 19 MeV. The residual energy spectra were measured with surface barrier silicon semiconductor detectors. The experimental results show good agreement with the theory of Bohr. (auth)

35203 INTERACTION OF 300-keV MONOENERGETIC ELECTRONS WITH THIN, COOLED (200 K) FILMS. Balladore, J. L.; Marais, Bernard; Martinez, J. P. (CNRS, Toulouse). Compt. Rend., Ser. B; 274: No. 4, 233-6(24 Jan 1972). (In French).

The transmission of 300-keV electrons by thin polycrystalline Ge, Ag, and Au films was studied at 200°K. The results obtained confirm the hypothesis suggested for paratransmission. The total, elastic, and inelastic mean free paths are calculated as are the a and b parameters of the atomic model proposed. (France)

35204 CLASSIFICATION OF PROBLEMS IN THE DOSIMETRY AND SOME ASPECTS OF MICRODOSIMETRY. Ivanov, V. I. (Moscow Engineering-Physics Inst.). pp 3-9 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The main problem of dosimetry is the quantitative evaluation of radiation effects, as determined from measured physical quantities. A radiation effect is any measurable physical, chemical, or biological effect caused by ionizing radiation. The physical quantities having a known relationship with a radiation effect constitute a class of dosimetric quantities. The existence of a known relationship between a radiation effect and the dosimetric quantities is their essential feature and determines the range of ionizing radiation dosimetry. The measurement of dosimetric quantities outside this relationship is not within the scope of dosimetry. The primary cause of any radiation effect is the transfer of radiation energy. Measurement of the energy transferred to matter is the basic problem in experimental dosimetry. Of great importance is the magnitude of the model volume, the energy absorption of which gives an idea of the radiation effect. In each specific dosimetric problem, limitations determined by the smallness criteria are imposed on the dimensions of the model volume. The problems of dosimetry are classified on the basis of these criteria. The place and significance of microdosimetry in this system are discussed, and the results of some microdosimetry studies performed by Soviet scientists are given. (auth)

35205 TRACK THEORY AND RADIATION QUALITY. Katz, R. (Univ. of Nebraska, Lincoln). pp 11-23 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Radiation detection and damage data from several physical, chemical, and biological systems have been analyzed by a unified track theory, in which observed effects are attributed to the interaction of secondary electrons with the medium. Gamma dose-response curves are combined with calculations of the spatial dose distribution about an ion's path to yield dose-response curves (survival curves) for heavy ion bombardment, through appropriately defined parameters. Perplexing phenomena associated with high LET radiation are sorted out according to track regime (grain-count or track-width), inactivation mode (gamma-kill or ion-kill), structural complexity (elementary, cellular, multicellular), and end-point. The central problem in assigning a quality factor to radiation lies in the fact that the variables describing the bombarding particle and those describing the medium are not separable. What seems to be required is a theory of survival curves in which cells are represented by measured parameters, from which their response to a particular radiation environment may be calculated. A start has been made in this direction. (auth)

35206 PARTICLE SLOWING-DOWN PROCESS AND LINEAR ENERGY TRANSFER (LET) SPECTRA. Petersen, M. C. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). pp 25-43 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Theoretical and experimental studies of the energy loss processes by charged and uncharged energetic particles which are slowed down in various media are reviewed. The relation between events in the two charge states caused by charge exchange collisions is discussed. The linear energy transfer (LET) to a medium from energetic particles in both charged and uncharged states differs significantly from the average LET. Specifically the LET of uncharged particles is greater than the average LET for particle energies greater than about 100 keV, while the LET for charged particles considerably exceeds the average LET at energies less than this. Actual LET values for a slowing-down particle in either the uncharged or charged state, rather than the average LET values, produce changes in calculated LET spectra as a function of the initial energy of the slowing-down particle. The changes in the LET spectra for protons slowing down in a hydrogenic medium are considered as a specific example. Some biological implications of these studies are discussed. (auth)

35207 MEANING AND ASSESSMENT OF RADIATION QUALITY FOR RADIATION PROTECTION. Turner, J. E. (Oak Ridge National Lab., Tenn.). pp 55-77 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

The physical qualities of ionizing radiation are considered in the light of the known ways in which radiation interacts with matter. Experimental evidence for the dependence of biological effects on different physical characteristics of the radiation and target (LET, energy, nuclear interaction, biological endpoint, etc.) is described. The kind and extent of information which is known from physics and which might be relevant for understanding some biological effects is reviewed. Two simple examples are considered in which the roles of various physical parameters can be seen explicitly. It is suggested that more attention be given the role of cross sections for various physical interactions in interpreting the effects of radiation. (auth)

35208 ANALYSIS OF DOSE-EFFECT RELATIONSHIPS BASED ON THE MICRODOSE CONCEPT. Oda, N. (Tokyo Inst. of Tech.); Numakunai, T.; Ohtani, S. pp 99-117 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

To interpret the effect of radiation quality on the radiobiological actions, the specific characteristics of the primary energy transfer of ionizing radiations must be taken into consideration when defining the input quantity in the target theory. The statistical distributions of the primary energy transfer, based on the microdose concept introduced by Rossi and Oda (N.O), were calculated for several kinds of radiations such as heavy ions of atomic number Z = 1 to 18 and of energy 4 to 12 MeV/amu, neutrons of 1 to 20 MeV, and ^{60}Co and ^{137}Cs γ rays. These results were used to assess the survival rates and the effective cross sections of biological targets, applying the new formulation of target theory based on the microdose concept. As examples of application of the results obtained, inactivation cross sections of enzymes and viruses by heavy ion bombardment are compared with experimental ones, which results in reasonable agreements, while results on the primary energy transfer for neutrons are compared with those by Boag which do not consider the contribution of delta rays. For γ rays the difference in target volumes obtained by the present theory and those by the conventional macrodose concept is discussed. (auth)

35209 FLUCTUATIONS IN THE PROBABILITY DISTRIBUTION FUNCTION FOR ENERGY TRANSFERRED TO A GIVEN VOLUME BY IONIZING RADIATION. Kalashnikov, N. P.; Remizovich, V. S.; Ryazanov, M. I. (Moscow Engineering-Physics Inst.). pp 127-38 of Biophysical Aspects of Radiation Quality. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on biophysical aspects of radiation quality; Lucas Heights, Australia (8 Mar 1971). See STI/PUB-286; CONF-710314.

Effects which may have to be taken into account in considering the probability distribution function for energy transfer to a small volume of matter by ionizing radiation are discussed. The influence of random inhomogeneities of an ionizing radiation flux on the probability distribution for energy transfer to a small volume of matter is considered. It is shown that fluctuations in the ionizing radiation flux lead to fluctuations in the probability distribution function for energy transfer. For this reason, the customary treatment of probability without allowing for fluctuations is valid to within values of the order of the ratio of the average distance between particles in the flux to the linear dimension of the volume. The effect referred to restricts the possibility of obtaining information on small volumes when low-intensity radiation fluxes are used. (auth)

35210 OBSERVATION OF ORIENTATION DEPENDENCE OF LOW-ENERGY ELECTRON-BEAM TRANSMISSION THROUGH SINGLE-CRYSTALLINE FILMS. Nishihara, H. (Osaka Univ.). Phys. Lett.; 39A: No. 4, 299-300(22 May 1972).

Low-energy (~3 keV) electron-beam transmission through single-crystalline palladium films 350 Å thick was observed to decrease distinguishably in the $\langle 110 \rangle$ or $\langle 111 \rangle$ orientations, depending on specimens. (auth)

35211 DESTRUCTIVE INTERFERENCE IN SCATTERING OF FAST ELECTRONS IN A SINGLE CRYSTAL. Kalashnikov, N. P.; Koptelov, E. A.; Ryazanov, M. I. (Moscow Engineering-Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 15: No. 2, 83-5(20 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 2, 120-2(20 Jan 1972).

For crystal thicknesses exceeding the Born limit, the interference effect in scattering differs from that considered by Ter-Mikaelyan (Zh. Eksp. Teor. Fiz. 25: 289(1953)). If $L < pK^{-2}$, the high-energy approximation can be used for the amplitude of scattering by the single crystal as a whole. Equations are derived for the total and differential cross sections. The meaning of the solution is explained by considering the scattering by two centers located at $\vec{r} = o$ and $\vec{r} = \vec{a}$. The case where the centers are of the

Coulomb type is also considered. Results show that the interference effect occurs only in sufficiently thin crystals with $L < (a/Ze^2)$. For small z, this thickness does not exceed 10^2 monatomic layers. (D.L.C.)

35212 STOPPING POWERS OF SOME SOLIDS FOR 30- TO 90-MeV ^{238}U IONS. Brown, M. D.; Moak, C. D. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 6: No. 1, 90-4(1 Jul 1972).

Uranium ions of energies in the range 30 to 90 MeV from the Oak Ridge Tandem accelerator were used to measure stopping powers for C, Al, Ni, Ag, and Au foils. Foil thicknesses were determined by α-particle energy-loss measurements. The results are compared with various theoretical predictions. Subtraction of an assumed nuclear-stopping component leaves a residual electronic stopping power which is velocity-proportional but does not appear to extrapolate to the origin, in disagreement with theory. Comparisons with other ions indicate that heavier ions exhibit larger discrepancies with theory in that the velocity-proportional stopping extrapolates to zero stopping at larger values of velocity. (auth)

35213 STOPPING POWER OF SOME PURE METALS FOR 25- TO 250-keV HYDROGEN IONS. Valenzuela, A.; Meckbach, W.; Kestelman, A. J.; Eckardt, J. C. (Centro Atomico Bariloche, Rio Negro, Argentina. Instituto de Fisica, Rio Negro, Argentina). Phys. Rev., B; 6: No. 1, 95-102(1 Jul 1972).

Electronic stopping powers for a hydrogen beam at energies between 25 and 250 keV are measured in the metals Ni, Cu, Ag, Sn, and Au using the straightforward technique of measuring the energy loss of a beam traversing a thin target foil. The metal foils, fabricated specifically for this purpose, are self-supported and thin enough to ensure an energy loss of 10% or less for a 25-keV proton beam. The measured stopping powers are given relative to accepted published values at 250 keV. The results are compared to those of other authors, primarily at the low-energy end of the present measurements where a comparison with the theory of Lindhard and Scharff is also possible. Available information about stopping powers of hydrogen beams in other elements together with the present results are represented as a function of z_2, the atomic number of the target material. A periodic structure in this diagram is observed that can be related to the filling of electronic shells in the target atoms. (auth)

35214 STOPPING POWER PARTITION AND MEAN ENERGY LOSS FOR ENERGETIC PROTONS IN HYDROGEN. Wilson, W. E. (Pacific Northwest Labs., Richland, Wash.). Radiat. Res.; 49: No. 1, 36-50(Jan 1972).

Recent measurements of electron ejection cross sections, differential in electron energy and emission angle, for energetic protons were analyzed to give the total ionization cross section, and the mean energy of the first-generation secondary electron produced in single collisions of protons with hydrogen molecules. These data are used to determine the fraction of the energy lost by the proton in overcoming the electron-binding energy in the target molecules and also the fraction transformed into kinetic energy of first-generation secondary electrons. The fraction of the energy loss which goes to overcome the binding energy of the ejected electron is about 30% for 0.1 MeV protons and decreases monotonically to approximately 20% at 1.5 MeV. The fraction of the energy which is carried away as kinetic energy by the first-generation secondary electrons is about constant at approximately 60% over the same proton energy range. The remaining fraction of the total stopping power is accounted for in excitation and recoil energy of the residual ions and atoms. This information gives a quantitative picture of the energy partition for energetic protons at the beginning of the physical stage of radiation action. (auth)

35215 CHANGES IN THE FREQUENCY DISTRIBUTION OF ENERGY DEPOSITED IN SHORT PATHLENGTHS AS A FUNCTION OF ENERGY DEGRADATION OF THE PRIMARY BEAM. Baily, Norman A.; Steigerwalt, John E.; Hilbert, Jerald W. (Univ. of California, San Diego, La Jolla). Radiat. Res.; 49: No. 1, 26-35(Jan 1972).

The frequency distributions of event size in the deposition of energy over small pathlengths were measured after penetration of 44.3-MeV protons through various thicknesses of tissue-equivalent material. These distributions were measured over a range of penetration extending from zero thickness to thicknesses of muscle-equivalent plastic close to that corresponding to the total range of the protons. These distributions are those associated with the passage of the proton through 0.667×10^{-4} g/cm^2 of a tissue-equivalent gas. The transition from the region where statistical fluctuations dominate to that where a significant spread in beam energy has taken place is clearly demonstrated. In no instance does it appear that the concept of dose based upon a value of the stopping power or average energy deposited adequately defines the energy delivered to a structure having the dimensions usually associated with those of biological significance if only a relatively small number of events are required for induction of damage. (auth)

35216 TRANSMISSION ENERGY LOSS OF LIGHT CHANNELED PARTICLES IN THIN SILICON SINGLE CRYSTALS. Della Mea, G. (Univ., Padua); Drigo, A. V.; Lo Russo, S.; Mazzoldi, P.; Bentini, G. G. Radiat. Eff.; 13: No. 1-2, 115-19 (Mar 1972).

The energy losses of light ions channeled through Si were investigated by studying the energy distribution of the transmitted particles. Beams of protons, deuterons, and helium ions were used in the energy range from 0.9 to 5.0 MeV. Measurements of the energy losses were made for the ⟨111⟩, ⟨112⟩, ⟨110⟩ axial and {111}, {110} planar directions. Comparison of the energy loss for different particles shows a correlation with a simple velocity-dependent function. The energy loss as a function of the incident energy is discussed in terms of localized and nonlocalized components of the stopping power. (auth)

35217 PHOTON CROSS SECTION COMPILATION ACTIVITY IN THE U. S. IN THE RANGE 1 keV TO 100 GeV. Hubbell, J. H. (National Bureau of Standards, Washington, D. C.). J. Phys. (Paris), Colloq.; No. 4, 14-20(1971).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

A brief survey of photon cross-section (attenuation coefficients) data available over the 10-eV to 100-GeV range of photon energies for elements with Z lying between 1 and 100 is presented. Data from literature (1909–1970) are filed at the X-ray Attenuation Coefficient Information Center of the NSRD (National Standard Reference Data Center) at NBS. These data and recently available theoretical values for photoabsorption, scattering, and pair production cross sections are integrated into permanent evaluation and compilation programs of the NBS at the LRL (Lawrence Radiation Laboratory Livermore) and elsewhere. Current compilation studies of the NBS (10 keV to 100 GeV, 23 elements) and by LRL–NBS (1 keV to 1 MeV, 87 elements) are described and compared with input information. Compilation uncertainties from Z interpolation and the fine structure of the absorption edge are discussed. (France)

35218 ATTENUATION COEFFICIENTS OF GASES FOR 4.5 TO 145 keV PHOTONS. McCrary, J. H. (EG AND G, Inc., Las Vegas, Nev.). J. Phys. (Paris), Colloq.; No. 4, 21-5(1971).

From International conference on simple and multiple electronic processes in x and xuv region; Paris, France (21 Sep 1970).

Narrow-beam mass attenuation coefficients were measured for air, hydrogen, helium, neon, argon, krypton, and xenon. Radioisotope sources were used to provide photons whose energies were 4.508, 5.895, 9.243, 27.380, 44.229, 88.09 and 145.43 keV. Hydrogen and helium measurements were made only at 5.895 keV. Experimental errors were less than 2% for most of the measurements. (France)

35219 FREQUENCY DISTRIBUTIONS OF ENERGY LOSS BY FAST CHARGED PARTICLES AFTER PASSAGE THROUGH LARGE THICKNESSES OF TISSUE-EQUIVALENT MATERIALS. Baily, Norman A. (Univ. of California, San Diego, La Jolla); Steigerwalt, John E.; Hilbert, Jerald W.; Tanner, Raymond L. Health Phys.; 22: No. 5, 497-502(May 1972).

Frequency distributions of the energy deposition by 600 MeV protons in small volumes as a result of their traversal of a tissue-equivalent gas were measured after the beam's passage through various thicknesses of a tissue-equivalent plastic. A continuous flow proportional counter of tissue equivalent plastic was used in the measurements. The pathlength examined was equivalent to 1.75 μ of unit density tissue (muscle). Comparisons of the energy deposition distribution functions after passage through 0, 5 and 21 cm of tissue-equivalent plastic (muscle) are given. Through the use of a coincidence gate, spectra depicting energy deposition due only to direct proton ionization in the gas were compared with those combined with contributions due to the nuclear interaction products. (UK)

35220 MEASUREMENT OF IONIZATION DISTRIBUTIONS IN TISSUE-EQUIVALENT GAS. Glass, W. A.; Roesch, W. C. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res.; 49: No. 3, 477-94(Mar 1972).

The ionization distributions produced in small, cylindrical, tissue-equivalent sites by beams of protons of cross section much smaller than the sites were measured. Proton energies were 1.7, 3.0, and 4.0 MeV. The heights of the sites equaled their diameters; diameters were 25 and 100 μg/cm^2. Beams were positioned at distances from 0.3 to 3 times the radius from the center of the site. The properties of compound-Poisson processes are used to explain the trends in the shapes of the distributions and to obtain some information about the ionization distributions due to individual interactions between protons and molecules of the medium. A method of transforming measured distributions into what they would have been had the number of interactions been different is described and applied to comparison of the measured distributions. The ionization distributions for uniform beams of protons were calculated. They show the effects of the straggling in energy loss of the protons and confirm that the increase in the distribution at low energies is due to secondary radiations from protons that do not enter the site. (auth)

Radiation Protection Standards

35221 PROTECTION AGAINST RADIATION FROM BRACHYTHERAPY SOURCES. NCRP Report No. 40-1972. Washington, D. C.; National Council on Radiation Protection and Measurements (1972). 68p.

A guide to ensure the radiation protection of patients and medical personnel during the use of sealed radiation sources for brachytherapy is presented. Procedures for handling, storage, repair and re-encapsulation, and accountability of sources, as well as safety measures during clinical applications are covered. Emergency procedures to be followed in the event of rupture, decontamination procedures, and procedures to be followed in the event of loss of a source are included. (C.H.)

35222 QUANTITIES AND UNITS IN HEALTH PHYSICS. Wagner, S. (Physikalisch-Technische Bundesanstalt, Brunswick). Health Phys.; 22: No. 5, 521-2(May 1972).

It is considered by the author that health physics does not constitute a new branch of physics in itself but that an application of the physical knowledge to a certain domain, i.e., radiation protection of man, is indicated. Thus the term health physics alone cannot justify the introduction of new quantities and units and even new basic quantities. On the contrary the rational principle to keep the number of quantities and units to a minimum should be followed and, hence, one should try to do the best with existing ones. Examples are given. (UK)

Radiation Source Calibration and Standardization

35223 (SFL-A-18) MEASUREMENTS OF RADIATION OUTPUT OF TELECOBALT UNITS IN FINLAND. Rannikko, Simo; Uotila, Ilkka; Kiviniitty, Kalevi (Institute of Radiation Physics, Helsinki (Finland)). Dec 1971. 14p. Dep. NTIS (U. S. Sales Only).

Determination of the radiation output of the therapeutic ^{60}Co units in Finland was performed applying both ionization and thermoluminescence dosimetry. Exposure in air and absorbed dose in an acrylic plastic phantom were measured. The measurements show that exposure determinations are not reliable enough to be used as the basis for clinical dosimetry. Absorbed dose determinations gave results significantly more consistent with the existing depth–dose data. The measurements indicate that determination of absorbed dose in a solid material utilizing the so-called C_λ method is accurate enough for clinical dosimetry of ^{60}Co radiation. (Finland)

35224 PRIMARY STANDARD PHOTON BEAMS. Guiho, J. P. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 33-41(Oct 1971). (In French).

In photon dosimetry it is absolutely necessary to have a coherent system of reference that can be interrelated with national and international intercomparisons, the calibration of secondary standards, and studies and comparisons using different measurement techniques. Beams of suitable energy have been chosen as calibration standards, each of these beams being identified by all the dosimetric parameters characterizing the radiation field. Three beams with different energies have been chosen: ^{241}Am, ^{137}Cs, and ^{60}Co. The beams are characterized by the exposure rate and the energy fluence. The methods used are described, and a critical analysis of the various correction factors is made. The overall accuracy obtained in defining the beam exposure rates varies between 1.1 and 1.4%. (France)

35225 CALIBRATION BY COMPARISON WITH PRIMARY STANDARD ACTIVITIES. Legrand, J.; Perolat, J. P. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. Sci. Tech. (Paris); No. 163, 29-32(Oct 1971). (In French).

The requirement of high-quality secondary standards necessitates comparisons with primary standards (^{241}Am and ^{90}Sr) preferably by nondestructive methods. Calorimetry is the only possible nondestructive technique for pure α and β emitters. In the case of γ emitters, γ spectrometry using Ge(Li) detectors has already been used for indirect absolute measurements of certain complex radionuclide decay schemes. The calibration of such a spectrometer, using one or more multiple wavelength emission primary standards might permit this instrument to be used as a secondary standard in the future. Equipment facilitating the production of multiples or submultiples of the ^{241}Am and ^{90}Sr primary standards by comparison techniques, is described. In order to utilize the methods described, improvements are needed in the fields of calorimetry and the knowledge of decay scheme parameters (mean energies, % γ emissions, etc.) (France)

35226 EMPIRICAL DOSE QUALITY DISTRIBUTIONS OF ^{252}Cf. Oliver, George D. Jr. (Univ. of Texas, Houston); Quam, W. M.; Wilde, W. O. Health Phys.; 22: No. 4, 341-9(Apr 1972).

LET distributions from ^{252}Cf and ^{226}Ra tube sources were measured in a sphere of simulated tissue with and without moderating media surrounding the sphere and as a function of depth in the media. The detector was a tissue-equivalent spherical proportional counter of $\frac{1}{2}$ in. dia. The distributions of absorbed dose in LET were obtained over the respective ranges lying between 0.2 and 1000 keV/μm at effective chamber diameters of 0.7 and 1.9 μm. A single Cf source (16.5 μg) and an array of 8 Cf sources (93 μg) were used at depths of 1 to 10 cm from the detector. A 20 mg Ra tube also was used. A computer code was used to assimilate the data in a reproducible and objective manner. The measurement of LET distributions provided neutron dose rates, dose average LET values, and insight to the quality changes of the radiation as a function of depth into tissue material. (auth) (UK)

35227 NEUTRON SPECTRA OF ALPHA-BERYLLIUM NEUTRON SOURCES. Pauw, H.; Aten, A. H. W. (Instituut voor Kernphysisch, Amsterdam). Health Phys.; 22: No. 5, 511-14 (May 1972).

The component with energy $E < 1.5$ MeV of the neutron energy spectrum from radioactive neutron sources of the α-Be type was measured by activating In and Au spheres. The reactions ^{115}In$(n,\alpha)^{116}$In and ^{197}Au$(n,\alpha)^{198}$Au have cross sections that are much higher for energies below 1 MeV than for neutrons of a few MeV or higher. It was thus possible to calculate the contribution to the activity from neutrons with $E > 1.5$ MeV. The contribution of slow and epithermal neutrons to the spectra was shown to be negligible by comparison of the activities from the spheres with and without a surrounding shell of ^{10}B. The results for the fraction of neutrons with $E < 1.5$ MeV agreed well with the fission measurements carried out on thin layers of ^{239}Pu and ^{238}U. The average energy for neutrons with $E < 1.5$ MeV was derived from the measurements obtained from the four sources considered, i.e., ^{241}Am–Be, ^{239}Pu–Be, ^{226}Ra–Be, ^{242}Cm–Be. (UK)

35228 ISOTOPIC Be (α,n) SOURCE WITH A NEUTRON LINE SPECTRUM. Tyufyakov, N. D.; Shtan, A. S.; Trykov, L. A.; (and others). At. Energ. (USSR); 32: No. 3, 235-6(Mar 1972). (In Russian).

The neutron energy spectrum of a laminated source comprised of ^{238}PuO$_2$ and Be mounted on a stainless-steel support was investigated. A stilbene-crystal spectrometer was used in connection with a 512-channel analyzer. Experimental results are shown for measurements at angles of 180, 0, and 90°. A year's operation with the source has shown that adjustment is extremely easy, and that the unit is stable and reliable. (K.S.W.)

Shielding Calculations and Theory

Refer also to abstracts 34025, 35193, and 35564.

35229 WALLS SHIELDING AGAINST IONIZING RADIATION: LEAD BRICKS. DIN 25 407-1971. Berlin; Fachnormenausschuss Kerntechnik (1971). 6p. (In German).

Standards are given for lead bricks used in wall shielding against ionizing radiation. Specified are basic forms, measurements, types, and terminology. Also specified are required properties, raw material, and surface coating. The standards represent pre-norms which can be used but may require later adjustments. Significant parts correspond to EURATOM specifications. In 10 months, the pre-norms will be compared with practical experience and, if justified, will be converted into normal standards. (H.B.G.)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 33452, 33457, 33513, 33517–33519, 34852, 34919, and 35216.

35230 (COO–3158-3) IN SITU FIELD ION MICROSCOPE STUDY OF IRRADIATED PLATINUM. I. STAGE I RECOVERY BEHAVIOR. Petroff, P.; Seidman, David N. (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). Dec 1971. Contract AT(11-1)-3158. 30p. Dep. NTIS.

Direct visual evidence for uncorrelated long-range migration of self-interstitial atoms (SIA's) in Substage I_E of irradiated platinum was obtained by a series of in-situ field ion microscope (FIM) experiments. High-purity ((2 to 6) $\times 10^{-5}$ and (1 to 3) $\times 10^{-6}$ at.fr. impurity level) platinum specimens were irradiated with 20- or 30-keV Pt^+ ions under ultrahigh-vacuum conditions at a specimen temperature of 10 or 11°K. The initial damage pattern at 10°K consisted of depleted zones within ~100 Å of the irradiated surface and a distribution of immobile SIA's in the bulk of the specimen. Next, the specimens were isochronally warmed from 10 or 11°K to 75°K [average linear warming rate = $(^1/_3)$°K min^{-1}] at a constant value of the imaging electric field while the specimens' surfaces were photographed at a rate of 1 frame sec^{-1}. This experiment showed that a flux of SIA's crossed the specimens' surfaces between 13 and 27°K. A detailed series of control experiments were performed to demonstrate that the contrast effects observed were not due to impurity atoms or surface artifacts. Application of the diffusion model (Scanlan, Styris and Seidman) to the isochronal recovery spectrum yielded an enthalpy change of migration of ~0.04 eV and a diffusion coefficient of ~(0.08 to 0.77)exp(−0.04 eV/kT) cm^2 sec^{-1} for the SIA. (auth)

35231 (JUL–810-FF) DIFFUSE X RAY SCATTERING IN THE REGION OF THE BRAGG REFLEX OF ALUMINUM AFTER LOW-TEMPERATURE ELECTRON IRRADIATION. Ehrhart, Peter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerperforschung). Dec 1971. 81p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen (West Germany).

Diffuse x-ray scattering near the region of Bregg reflex was measured in single aluminum crystals after low-temperature electron irradiation until defect formation. Measurements were performed at the 200, 400, 220, and 222-reflexes parallel and at right angles to the scattering vector. From the measurements, conclusions about the nature of lattice defects were made. (H.B.G.)

35232 (LYCEN–7178) NO EXPERIMENTAL EVIDENCE FOR A CHANNELING EFFECT IN THE LIGHT EMISSION FROM ION BEAMS EXCITED BY GOLD CRYSTALS. Poizat, J-C.; Remillieux, J.; Desesquelles, J. (Lyon Univ. (France). Institut de Physique Nucleaire). Oct 1971. 6p. Dep. NTIS (U. S. Sales Only).

Optical emission was observed after the excitation of a 600 keV He^+ beam by 300 to 600-A-thick Au crystals. Channeling effects were not observed in the three He^+ lines studied. (France)

35233 (UCRL–51194) SURFACE THRESHOLD DISPLACEMENT ENERGY MEASUREMENT OF SILICON. Barnes, John J. (California Univ., Livermore. Lawrence Livermore Lab.). 17 Mar 1972. Contract W-7405-eng-48. 24p. Dep. NTIS.

Thesis.

A combination of low-energy electron-diffraction (LEED) techniques and Auger spectroscopy is used to examine the production of surface damage on silicon. Controlled damage of a Si(111) surface is produced and the extent of damage is monitored by the reduction of the integral-order LEED beams. Surface contamination is monitored by Auger spectroscopy before and after damage production to insure that the results apply to a clean silicon surface. The degradation caused by He^+ ion bombardment in the range 10 to 80 eV is measured and compared with previous data of other workers on Ge (Ar^+ ion bombardment). Measured degradation data for the Si(111)-7 surface indicate that no sharp surface threshold displacement energy occurs. Degradation went to completion for each of the bombardments before a dose of 10^{16} ions/cm^2, in contrast to the Ge data. LEED beam-broadening measurements are used to distinguish between degradation due to lattice distortion and localized structural defects such as vacancies. Preliminary results indicate that the low-energy He^+ ion degradation is due to displacement damage. (auth)

35234 PINHOLE CAMERA FOR THE OBSERVATION OF CHANNELLING PHENOMENA. Nip, H. C. H.; Williams, J. S. (Univ. of New South Wales, Sydney). Radiat. Eff.; 12: No. 3-4, 171-4(Feb 1972).

A small vacuum pinhole-camera incorporating a diffuse radioactive source and a track-registering film was used to observe channelling phenomena in thin single crystals. This simple technique provides a striking demonstration of axial and planar channelling without the need for a well-collimated beam of charged particles in high vacuum. The resulting pinhole-channelling pattern is analogous to a blocking pattern in so far as it is a projection of the crystal geometry in real space. As an example a pattern obtained with a (111)-oriented silicon crystal is shown. (auth)

35235 HYPERCHANNELING, AN AXIAL CHANNELING PHENOMENON. Appleton, B. R.; Boak, C. D.; Noggle, T. S.; Barrett, J. H. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 28: No. 20, 1307-11(15 May 1972).

The behavior of 21.6-MeV I ions undergoing proper axial channeling (hyperchanneling) in Ag was studied. Ions of this special class traverse the crystal within a single axial channel and as a result exhibit conspicuously lower energy losses and an order of magnitude smaller acceptance angles than ordinary axially channeled ions. Analysis of the results indicates that hyperchanneled ions provide a new means for studying multiple scattering radiation damage and ion–atom potentials in solids. (auth)

35236 DEDUCTION OF CONTINUUM POTENTIALS FROM PLANAR CHANNELING. Gibson, W. M. (Bell Telephone Labs., Murray Hill, N. J.); Golovchenko, J. Phys. Rev. Lett.; 28: No. 20, 1301-4(15 May 1972).

A new method for determining planar continuum potentials from planar channeling data was developed. Preliminary experiments were done for 1.8-MeV α particles in [111] gold planar directions from which the continuum potential was deduced. (auth)

35237 USES OF THE MOESSBAUER EFFECT IN RADIATION-DAMAGE STUDIES. Schroeer, Dietrich; Lambe, Randolph L.; Spencer, Charles D. (Univ. of North Carolina, Chapel Hill). Moessbauer Eff. Methodol., Proc. Symp.; 7: 3-19(1971).

From seventh symposium on Moessbauer effect methodology; New York, N. Y. (31 Jan 1971).

A review is presented of contributions which Moessbauer spectroscopy can make to studies of radiation-damage effects. Special emphasis is placed on the unique aspects of this technique, including the following examples: in all Coulomb excitation, as well as in some radioactive decay processes, every Moessbauer gamma ray has its origin in a radiation-damage event, leading to high sensitivity; all chemical charge states of a Moessbauer ion can be simultaneously observed and identified through the isomer shift; the Moessbauer effect is particularly sensitive to the local details of the damage effects; and radiation-damage processes with recovery times as short as the nuclear lifetimes can be studied. Some of the more significant contributions of the Moessbauer effect to a variety of radiation-damage questions are illustrated by reviewing experiments from the existing literature. (48 references) (auth)

35238 VARIATIONS IN OPTICAL PROPERTIES OF MUSCOVITE DUE TO 70 keV PROTON IRRADIATION. Christiaan de Wys, E. (Texas Tech. Univ., Lubbock); Bhansali, K. J. Mineral. Mag.; 38: No. 297, 631-2(Mar 1972).

The effect of high energy (70 keV) protons with a total fluence of 8.3×10^{16} protons per cm^2 on mica crystals was investigated as part of an initial study of solar wind bombardment of minerals. The drastic change in optical properties that was demonstrated would indicate a significant change in the refractivity related to either a decrease in the polarizability or a dimensional change of the mica lattice. Initial X-ray topography by means of a Lang camera before and after irradiation revealed significant damage to the mica lattice resulting in dislocation and additional mosaic structures. (UK)

35239 DISORDERING OF AN ORDERED ALLOY BY ELECTRON BOMBARDMENT. Cordier, Alain; Degeilh, Andre (CNRS, Toulouse). Compt. Rend., Ser. B; 274: No. 4, 229-32 (24 Jan 1972). (In French).

The number of atoms replaced when a crystal is bombarded with a 1.2-MeV beam of an electron microscope was calculated. The results were used to deduce the variations in the degree of order of an irradiated Ni_3Mn alloy along different crystallographic directions. (France)

35240 X-RAY EXAMINATION OF THE REAL STRUCTURE OF γ-IRRADIATED $NaClO_3$ SINGLE CRYSTALS. Stepien, J. A. (Inst. for Low Temperature and Structure Research, Wroclaw); Auleytner, J.; Lukaszewicz, K. Phys. Status Solidi (a); 10: No. 2, 631-8(16 Apr 1972).

Using a two-circle diffractometer and an oscillating-film spectrometer, the real structure of $NaClO_3$ single crystals irradiated by γ rays at various doses up to 2.8×10^8 rad is examined by following the changes of the lattice constant and the broadening of diffraction profiles. Analysis of the results shows that in the initial stage of radiolysis, the changes observed are due to the strains introduced in the lattice by the decomposition products. At higher doses, mosaic blocks are formed which gradually undergo disorientation. At the dose $\sim 7 \times 10^7$ rad, the strains are partially relaxed and at $\sim 2 \times 10^8$ rad, NaCl crystallites oriented parallel to the $\langle 100 \rangle$ directions of the host lattice appear. A tentative explanation of the phenomena is given. (auth)

35241 PROPERTIES OF FISSION SPIKES IN UO_2 AND UC DUE TO ELECTRONIC STOPPING POWER. Blank, H. (Europaeisches Institut fuer Transurane, Karlsruhe, Ger.). Phys. Status Solidi (a); 10: No. 2, 465-78(16 Apr 1972).

For the electronic stopping power of fission fragments in UO_2 and UC, a distinction is made between the initial energy distribution of width r_i around the path of the fission fragment and a limiting temperature distribution with width r_i'. A value of r_i' can be fixed in a way which allows one to compare different substances, here UO_2 and UC. The real temperature distribution depends upon the ratio $n = r_i r_i'$. Using transmission electron microscopy, the ratio n is found to be close to one for U_4O_9 and the same is concluded for UO_2. This initial temperature distribution is used to calculate the thermoelastic stress field around a fission spike in UO_2. A rough estimate for UC shows that $n \gg 1$, meaning that the thermoelastic stress field in UC is of no practical importance, like in metals. (auth)

35242 ANNEALING OF DEFECTS PRODUCED BY ROOM TEMPERATURE IRRADIATION IN NOMINALLY PURE KCl CRYSTALS. I. Seretlo, J. R. (Univ. of Fort Hare, S. Afr.). Phys. Status Solidi (a); 10: No. 2, 639-50(16 Apr 1972).

Results of investigations are given of the annealing of defects produced by room-temperature irradiation in nominally pure KCl crystals. A one-to-one correspondence between the annealing of the F and V_3 bands establishes the latter as due to interstitial centers. An estimate of the oscillator strength of the V_3 band is given. The kinetics order and activation energy for the $F-V_3$ reaction are deduced from the results. (auth)

35243 CARRIER LIFETIMES IN LOW-RESISTIVITY GaAs UPON ELECTRON BOMBARDMENT AND ANNEALING. Kladis, D. I.; Euthymiou, P. C. (Univ. of Athens). Phys. Status Solidi (a); 10: No. 2, 479-85(16 Apr 1972).

Single crystals of GaAs, n- and p-type, were bombarded with 1-MeV electrons at 78°K. By photoconductivity and photomagnetoelectric measurements, a decrease of majority and minority carrier lifetime was detected in all cases. The bombardment dose was small and hence the changes of carrier concentration and mobility were insignificant. The decrease of lifetimes is hence due solely to the increase of the number of recombination and trapping centers. Isochronal annealing experiments showed a complete, more or less, recovery for n-type specimens at about 300°K, while the recovery of p-type specimens is expected to occur at higher temperatures. The recovery takes place through three normal annealing stages for both types of specimens, in accordance with the Fletcher and Brown theory. Discrete reverse annealing stages were also found at temperatures usually below each normal annealing stage. This is attributed to the increase of the activity of the recombination and trapping centers due to a rearrangement of the associated defects to more stable states. (auth)

35244 NEAR-INFRARED OPTICAL AND PHOTOELECTRIC PROPERTIES OF Cu_2O. I. INFRARED ABSORPTION IN Cu_2O AFTER ANNEALING IN OXYGEN OR He^+ PARTICLES BOMBARDMENTS. Prevot, B.; Carabatos, C.; Sieskind, M. (CNRS, Strasbourg). Phys. Status Solidi (a); 10: No. 2, 455-63(16 Apr 1972).

The effects on the infrared absorption of annealing polycrystalline samples of Cu_2O under oxygen atmosphere are reported. The absorption near the fundamental edge is characterized by several absorption bands with peaks at 0.65, 0.76, 0.88, 0.95, 1.10 μm and the strongest at 1.28 μm. These bands appear simultaneously and their magnitude depends upon the oxygen pressure during the annealing with a $(p_{O_2})^{1/4}$ law. In the same region of the spectrum, the effects of irradiation by α particles from 1 to 3 MeV on analogous samples are studied also. Weaker bands appear at the same wavelengths. The approximate number of defects responsible for the absorption is estimated to be 10^{17} cm^{-3}. (auth)

35245 PARTICLE CHANNELING STUDIES. Quere, Y.; Mory, J. (CEN, Fontenay-aux-Roses, France). Bull. Inform. Sci. Tech. (Paris); No. 164, 3-16(Nov 1971). (In French).

Features of planar and axial channeling are recalled and the effects of this phenomenon on the propagation of charged particles are discussed. The simple channeling device developed at Fontenay-aux-Roses is described, and the images obtained are discussed. This setup allows small crystals (a few dozen microns) to be accurately oriented. It is shown that most lattice defects induce the dechanneling of particles, definitions of the principal parameters relating to dechanneling (dechanneling coefficients, opacity, etc.) being given. Experimental results are given for a number of defects: grain and twin boundaries, stacking faults, dislocations, interstitial atoms, Guinier—Preston zones, gas bubbles, and radiation-induced defects. (France)

35246 ULTRAHIGH VACUUM CHAMBER FOR THERMALLY STIMULATED CONDUCTIVITY MEASUREMENTS ON ION BOMBARDED CADMIUM SULPHIDE THIN FILMS. Ambridge, T. (Univ. of Salford, Eng.). J. Phys., E (London); 5: No. 3, 214-16 (Mar 1972).

An ultrahigh vacuum chamber was constructed in which it was possible to carry out measurements of electrical conductivity, including thermally stimulated conductivity, on cadmium sulphide films, in order to investigate and characterize the isolated defects introduced by low-energy inert-ion bombardment of the surface at low temperature. So that a clean surface is presented for investigation the CdS films are produced in situ and subsequent ion bombardment and measurements are made with no intervening exposure of the samples to contaminant gases. (auth)

35247 APPARATUS FOR INTERNAL FRICTION AND MODULUS DEFECT MEASUREMENTS DURING LOW TEMPERATURE ELECTRON IRRADIATION. Soulie, J. C.; Jodeau, J. P.; Depierre, Y.; Minier, C. (CEN, Grenoble, France). Radiat. Eff.; 11: No. 3-4, 221-5(Dec 1971).

A cryostatic apparatus is described for measuring internal friction and elasticity modulus during low-temperature electron irradiation. This cryostat is well adapted for dislocation pinning experiments. Its main advantages are facility for isochronal thermal pulses, homogeneity of the point defect density created during irradiation, and good evaluation of the mechanical deformation in the specimen. (auth) (UK)

35248 DOUBLE PEAK IN CHANNELING EXPERIMENTS. Kumakhov, M. A. (Moscow State Univ.). Phys. Lett.; 39A: No. 3, 191-2(8 May 1972).

The flux-peaking effect is examined for the cases of axial and planar channeling. The possibility for double and multiple peaks to arise in the angular distribution is demonstrated depending on the position of an impurity atom in the lattice. (auth)

35249 RADIATION-INDUCED $[Na]^0$ CENTERS IN MgO AND SrO. Abraham, M. M.; Chen, Y.; Kolopus, J. L.; Tohver, H. T. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 5: No. 12, 4945-51(15 Jun 1972).

Substitutional monovalent sodium ions in MgO and SrO trap holes when exposed to ionizing radiation at 77°K. The $[Na]^0$ centers thus formed have $\langle 100 \rangle$ axial symmetry at 4.2°K, and their spin-Hamiltonian parameters are reported. The isotropic part of the hyperfine interaction for $[Na]^0$, which has opposite sign to the anisotropic term, is larger than that observed for $[Li]^0$ in these hosts. Optical absorption bands were correlated with the $[Na]^0$ centers, and their peaks occur at 1.58 eV for MgO and 1.34 eV for SrO. Decay temperatures were determined to be approximately 190°K for MgO and 160°K for SrO. The EPR, optical, and thermal properties of these centers resemble those of the V^- and $[Li]^0$ centers. (auth)

35250 50-MeV ELECTRON IRRADIATION OF SILICON AND GERMANIUM STUDIED BY ^{57}Co MOESSBAUER PROBE. Matsui, K. (Tohoku Univ., Sendai); Onodera, H.; Ohkawa, A. Kakuriken Kenkyu Hokoku; 3: No. 2, 96-102(Dec 1970).

A preliminary 50-MeV electron irradiation of silicon and germanium crystals was made to study interactions between radiation-induced defects and ^{57}Co Moessbauer probe incorporated in the host lattices. Irradiation up to 3×10^{17} e^- s/cm^2 at 15°C induced in silicon conversion effects of interstitial and vacancy type with a Fermi-level dependence different from that observed for fast-neutron irradiation. The irradiation produced a new resonance line at +0.12 cm/sec in n-germanium, which disappeared in a few days at ambient temperature. (auth)

35251 USE OF INORGANIC ELECTRIC-INSULATING MATERIALS IN REACTORS. Aseev, N. A. At. Energ. (USSR); 32: No. 4, 326-8(Apr 1972). (In Russian).

The specific conductivity of some ceramic materials was measured as functions of the intensity of reactor radiation, temperature, and integral dose of fast neutrons. These materials included MgO, porcelain, and stabilized polyethylene, and the dose rate included all three types: γ radiation = 6.5×10^5 R/sec; fast neutron flux = 3.2×10^{14} n/cm^2·sec; and thermal neutron flux = 3.2×10^{14} n/cm^2·sec. The results are graphically depicted and discussed. (K.S.W.)

35252 HIGH-TEMPERATURE DEPENDENCE OF THE ELECTRON HALL MOBILITY IN γ-IRRADIATED KCl. Eisele, Ignatz; Kevan, Larry (Wayne State Univ., Detroit). J. Chem. Phys.; 56: No. 11, 5738-9(1 Jun 1972).

KCl crystals were made photoconducting by ^{60}Co γ rays in doses from 2.4 to 9 Mrad. The magnetic field was modulated at 3.3 Hz, and the electrons were excited by a chopped light beam at 90 Hz. The measured Hall voltage was due to electrons and was linear with the magnetic and electric fields. The Hall mobility at 300°K is 9.0 cm^2/V · sec, and over the range between 150 and 300°K follows the equation $\mu_H = 1.0\ exp\ (646/T)$. Theoretical implications of the results are considered briefly. (D.L.C.)

35253 DEPTH AND TEMPERATURE OF THE CHANNELING EFFECT IN DIATOMIC CRYSTALS. Hellborg, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Scr.; 4: No. 4-5, 203-14 (1971).

The depth and temperature dependence of the channeling effect were studied in diatomic single crystals of CaF_2 and BaF_2. The interactions between fast protons and the two sublattices were studied separately by using Rutherford scattering and by detecting gamma rays from the nuclear reaction $^{19}F(p,\alpha\gamma)^{16}O$. The experimental values of the critical angle at the surface are found to vary with temperature in agreement with calculations. Comparison in absolute values between calculations from an analytical formula given by Barrett and the experimental values shows the experimental values to be slightly larger than those predicted by Barrett for the direction ⟨111⟩ with mixed rows. For the directions ⟨110⟩ and ⟨100⟩, which consist of pure rows, the interaction between the protons and the "heavy-element rows" also gave slightly larger values than those predicted. On the other hand, smaller values than those predicted were obtained for the interaction with the pure fluorine rows. (auth) (Sweden)

35254 ELECTRIC CONDUCTIVITY OF CaF_2 WITH Ho^{3+} AND Nd^{3+} ADDITIONS IRRADIATED WITH PROTONS AND ELECTRONS. Lisitsyn, V. M.; Fedorov, V. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 10, 124-6(1971). (In Russian).

The temperature dependence of the electric conductivity of CaF_2 crystals was investigated, wherein the CaF_2 contained 0.03, 0.3, and 1% Nd and Ho. Measurements were conducted before and after room-temperature irradiation with 4.5-MeV protons and 1.2-MeV electrons. A significant increase in conductivity of the CaF_2 with added Nd and Ho was noted at temperatures below 200°C after irradiation with a dose of 4×10^7 R. (K.S.W.)

35255 IMPROVEMENTS IN OR RELATING TO SEMICONDUCTORS AND METHODS OF DOPING SEMICONDUCTORS. Nelson, Richard Stuart (to United Kingdom Atomic Energy Authority). British Patent 1,269,359. 6 Apr 1972. Filed 22 Aug 1968.

In order to form p- and n-type regions in semiconductors, dopant atoms are introduced into the material, and these atoms are effective only when they take up sites in the crystal lattice in substitution for the host atoms. Ion implantation is an effective method for introducing the dopant. The process described is based on the appreciation that the greater the radiation damage caused by ion implantation the greater is the chance, on annealing, for the implanted ions to take up substitutional lattice positions. The useful limit of radiation damage is that which will produce a substantially amorphous phase throughout the region it is desired to dope. This region is bombarded to a predetermined extent with electrically active ions which may be B ions, followed by bombardment with electrically inactive ions, the bombardment being accompanied or succeeded by annealing. A specific example of application of the process to Si is described in detail. (UK)

35256 ION-BOMBARDMENT-INDUCED SURFACE DAMAGE IN TUNGSTEN AND MOLYBDENUM SINGLE CRYSTALS. Bellina, J. J. Jr.; Farnsworth, H. E. (Brown Univ., Providence). J. Vac. Sci. Technol.; 9: No. 2, 616-19(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Clean, annealed W (110) and Mo (110) surfaces were bombarded by 10^{13} to 10^{15} noble-gas ions at 100 to 1000 eV. Degradation of intense peaks in the major LEED beams was observed with a rapid-scan, Faraday collector system. The dependence of the rate of degradation on ion mass and energy and target mass was determined to depend on the energy transferred in two-body, linear, hard-sphere collision. Comparison with sputtering yields and thermal desorption of embedded ions indicated when knock-on lattice distortion rather than direct sputtering or ion embedding probably caused the intensity degradation. (auth)

35257 STUDY OF INFRARED ABSORPTION IN ELECTRON- AND NEUTRON-IRRADIATED GALLIUM ARSENIDE. Vaidyanathan, Kavasseri Vanchi. Waterloo, Ont.; Univ. of Waterloo (1971).

Thesis.

Mechanically and chemically polished gallium arsenide samples were irradiated with 1.5-MeV electrons and with fission neutrons to fluences varying from 1.0×10^{17} to 1.0×10^{18} el/cm^2 and from 10^{16} to 1.4×10^{18} neutrons/cm^2, respectively. Results of infrared-absorption measurements in these crystals are presented. The structureless absorption observed at room temperature in electron-irradiated and low-fluence neutron-irradiated samples can be expressed by $\alpha(E) = A\ \exp\ (BE^2)$ where E is the photon energy. This variation is attributed to the presence of a tail in the density of states. In samples irradiated to fluences $>6 \times 10^{16}$ neutrons/cm^2, the absorption coefficient is found to vary linearly as the square of the photon energy. This variation can be explained on the basis of the presence of disordered regions containing metallic precipitates as suggested by McNichols and Ginell (J. Appl. Phys., 38: 656(1967)). A broad absorption band at 1.0 eV, associated with bound transitions, was observed in electron-irradiated samples at low temperatures. Weak absorption bands at 0.47 eV and at 0.25 eV were observed in neutron-irradiated samples at room temperature. (Diss. Abstr. Int., B)

35258 LOW-TEMPERATURE LATTICE THERMAL CONDUCTIVITY OF DEFORMED AND IRRADIATED Cu + 10 AT.% Al, AND DEFORMED Cu + 7 AT.% Ge. Friedman, Alan Jay. Storrs, Conn.; Univ. of Connecticut (1971). 184p. University Microfilms Order No. 72-14,230.

Thesis.

Phonon scattering studies by low-temperature thermal conductivity measurements can give information about the equilibrium arrangement of solute atoms in the strain fields of dislocations, and also about the rate at which equilibrium is attained. Impurity atmospheres around dislocations and the modification of the dislocation thermal resistivity due to these atmospheres were substantiated by Mitchell in a study of the annealing characteristics of the dislocation thermal resistivity in plastically deformed samples of Cu−10 at. % Al. It was also found that excess vacancies produced during deformation played a key role in the formation of these atmospheres. It is of interest to determine if atmospheres can be reformed around dislocations by irradiation with fast neutrons in a system in which the atmospheres produced during plastic deformation have been thermally dispersed by annealing below the recrystallization temperature. The effect was looked for in Cu−10 at. % Al, since atmospheres are known to form in this system. The effects of neutron damage on lattice conductivity were examined in two samples, one which is in the well-annealed state and one as described above, to separate the atmosphere reformation, from other radiation-produced defects which scatter phonons in the same temperature range. The results show that reformation does occur, and that additional defects are introduced into both samples by irradiation, which are identified as dislocation loops. In Klemens' theory, the mass difference between impurity in the host and the volumetric distortion of the impurity in the host lattice play a crucial role in the extent to which impurity atmospheres modify the dislocation thermal resistivity. A second series of thermal conductivity measurements is reported which seek to determine if impurity atmospheres form in Cu containing Ge impurities (Cu−7 at. % Ge), and if the mass difference and distortion dependence in the theory are substantiated in this system, for which these parameters are considerably different than in the Cu−Al system. No atmosphere effect is found, and several possible explanations are given for this null result in Cu-Ge. (Diss. Abstr. Int., B)

35259 EQUILIBRIUM TOPOGRAPHY OF SPUTTERED AMORPHOUS SOLIDS. III. COMPUTER SIMULATION. Catana, C.; Colligon, J. S.; Carter, G. (Univ. of Salford, Eng.). J. Mater Sci.; 7: No. 4, 467-71(Apr 1972).

When a nonplanar amorphous target is bombarded by a uniform beam of ions, sputtering occurs at different rates at various points across the surface. As a result, the original surface contours change, presenting different angles to the ion beam so that a continuous modification of the surface profile occurs until an equilibrium profile remains. A computer program was devised to follow the development of a general surface contour to the equilibrium conditions. The development of the program is described and preliminary results on a sinusoidal surface considered. (UK)

35260 SURFACE DAMAGE PRODUCED BY SPUTTERING OF SILICON. Davidson, S. M. (Oxford Univ.). J. Mater. Sci.; 7: No. 4, 473-4(Apr 1972).

When using the phenomena of sputtering for materials research it is important that the other effects of ion bombardment, the incorporation of a very large number of impurity atoms in the material, and the damage produced by collisions between ions and target atoms, should not be neglected. In this investigation, silicon was bombarded with 4-kV N^+ ions at an angle of 25° to the surface and the depth of damage measured using both electrical and electron microscope techniques. Ion beam-etched and anodically stripped profiles obtained are compared and discussed. (UK)

35261 ELECTRON EMISSION FROM SHALLOW ION-IMPLANTED P–N JUNCTIONS IN α-SiC. Chamberlain, N. G.; Lamb, D. R. (Univ. of Southampton, Eng.). Int. J. Electron.; 32: No. 5, 565-8(May 1972).

Shallow p–n junctions were formed by the implantation of nitrogen ions into p-type α-SiC. Preliminary measurements showed that these devices are capable of emitting electrons when under reverse bias, and the present indications are that these electrons are emitted through the shallow n-type layer. (auth)

35262 DECHANNELING OF PROTONS IN COPPER SINGLE CRYSTALS. I. Jack, H. E. Jr. (New York Univ., N. Y.). Radiat. Eff.; 13: No. 1-2, 101-10(Mar 1972).

The dechanneling of 150-keV protons impinging along the ⟨110⟩ direction in nearly perfect copper crystals was investigated by measurements of the 135° backscattered protons and of the yields of the characteristic Cu(L) x rays, as a function of the crystal temperature (300, 485, and 645°K) and the incident beam direction relative to the ⟨110⟩ channel. The data are analyzed and interpreted in a two-step procedure. First, the data are reduced in terms of the energies of the observed backscattered protons taking into account the contributions of dechanneled protons and of the protons knocked onto random trajectories by the surface atoms. Second, model backscattering spectra and x-ray yields are constructed by assuming various trial functions for the dependence of the dechanneling rate, on penetration depth. Two trial functions are tested. One is based on a small-angle multiple scattering model of dechanneling. The other assumes an exponential decay of the number of channeled protons, characterized by a mean free path until dechanneling. The data support the latter. The shortening of the mean free path with rising crystal temperature suggests that scattering on the thermally displaced lattice atoms is the primary cause for dechanneling. (auth)

35263 MONTE-CARLO CALCULATIONS OF THE BACKSCATTERING OF HIGH-ENERGY HEAVY IONS FROM METAL SURFACES. Guettner, K.; Ewald, H.; Schmidt, H. (Physikalisches Institut, Giessen, Ger.). Radiat. Eff.; 13: No. 1-2, 111-14(Mar 1972).

Random numbers are used to describe the plural scattering of fast heavy ions by amorphous metal films. Rather simple expressions for the single interactions are derived employing a screened Coulomb potential and with regard to the important energy losses of the particles in the foils. As a first result, the computer program yields qualitatively the shape of the particle trajectories in accordance with observed fission fragment tracks in thin metal films. Furthermore, the spatial distribution of the reflected particles together with the total reflection rate is studied as a function of the entrance angle. It is seen that the portion of the reflected particles decreases rapidly with increasing angle. Similarly, the penetration depths and the energy spectra are strongly influenced by the angle of the incident beam. The results are in satisfactory agreement with known experiments. (auth)

35264 ENERGY DISTRIBUTION OF SPUTTERED ATOMS FROM GOLD. Chapman, G. E.; Farmery, B. W.; Thompson, M. W.; Wilson, I. H. (Univ. of Sussex, Brighton, Eng.). Radiat. Eff.; 13: No. 1-2, 121-9(Mar 1972).

The energy spectra of atoms sputtered from a gold target were measured as a function of ion energy and species for target temperatures in the range 100 to 1200°K. Both single-crystal and polycrystal targets were used, with surface topography monitored by a scanning electron microscope. The effect of raising the target temperature towards 1200°K is always to produce a low-energy peak in the energy spectrum near 0.1 eV. This is found to have behavior consistent with a thermal-spike model, and at high temperature accounts for a large fraction of the total sputtering yield. The time-of-flight spectra show two peaks, one at about 10 eV and the other at about 500 eV. The former was always present and when a crystal target was used with ejection along a ⟨110⟩ axis, it took on a kinked shape consistent with a contribution from focused collisions. The effect of increasing the temperature was to reduce this effect, presumably by thermal scattering of focused collisions. The 500 eV peak was also affected by temperature, but in an indirect way connected with changes in surface topography. This peak, which accounts for less than 10% of the total yield, is consistent with the results of calculations based on a surface collision model. (auth)

35265 STOPPING POWER OF ENERGETIC HELIUM IONS TRANSMITTED THROUGH THIN SILICON CRYSTALS IN CHANNELLING AND RANDOM DIRECTIONS. Eisen, F. H. (North American Rockwell Corp., Thousand Oaks, Calif. Univ. of Aarhus, Denmark); Clark, G. J.; Boettiger, J.; Poate, J. M. Radiat. Eff.; 13: No. 1-2, 93-100(Mar 1972).

The stopping powers of helium ions transmitted through silicon in channeling directions (⟨110⟩ and ⟨111⟩ axes and {111} plane) and in random directions for the energy range from about 0.1 MeV to 18 MeV were determined. For the channeled cases, stopping cross sections were calculated using both the position of the leading edge and the peak of the channeled energy spectra. Evidence is presented to support the view that the leading edge of the energy spectrum corresponds to the energy loss of the best channeled particles. It was found that the ratio of the channeled-to-random stopping, using either of the above-mentioned channeled stopping powers, is a function of the helium-ion energy having a maximum value at the same energy at which the maximum in the stopping cross section is observed. For ⟨110⟩ channeling, this ratio for the best channeled ions varied from about 0.3 at 0.1 MeV to a maximum of about 0.55 and decreased to a limit of about 0.3 at high energies. The relation between the values of stopping powers determined in the authors' transmission experiments and those applicable to depth calculations in Rutherford-scattering experiments are discussed. (auth)

35266 CHANNELING EFFECTS ON RUTHERFORD SCATTERING YIELDS IN THIN SINGLE CRYSTALS. Poizat, J.-C.; Remillieux, J. (Univ. Claude Bernard, Lyon). Radiat. Eff.; 13: No. 1-2, 51-5(Mar 1972).

Results are presented on the Rutherford scattering yield of 1-MeV protons in a 500-Å thick gold crystal. Experimental results obtained for planar channeling are in good agreement with the theoretical values of the depth χ_m and the half-width $\psi_{1/2}$ that was obtained from a calculation in which the effects of the thermal motion of lattice atoms and the effects of nuclear multiple scattering on the scattering yield were taken into account. The experimental χ_m values obtained in numerous axes suggest that channeling effect on scattering yield in the axial case should be considered as a combination of planar effects. Calculations were recently extended to the study of the comparative influence of thermal motion of lattice atoms and nuclear lifetime on the blocking dip of emerging charged particles emitted from a nuclear reaction. (auth)

35267 Z_1 DEPENDENCE OF HEAVY-ION SPUTTERING YIELD IN COPPER. Andersen, H. H.; Bay, H. (Univ. of Aarhus, Denmark). Radiat. Eff.; 13: No. 1-2, 67-74(Mar 1972).

The sputtering yield of copper was measured with 21 different 45-keV ions as projectiles. The measurements were performed by means of an oscillating quartz microbalance. This allows the sputtering yield to be accurately measured even if only 40 to 50 Å of the target material was sputtered away. It was found that the measured sputtering yield depended sensitively on the previous irradiation of the target. It was therefore preferred to measure all sputtering yields relative to copper self-sputtering. This ratio of sputtering yields was found to be insensitive to previous bombardments and to agree well with Sigmund's theory, although small systematic disagreements are found. The overall agreement implies firstly that the modifications of the target during bombardment only affect the ejection conditions at the surface, and secondly that any Z_1 oscillations of the nuclear stopping power are less than 10%. (auth)

35268 CONTRIBUTION TO SPUTTERED EJECTION PATTERNS FROM COLLISION SEQUENCES IN ATOMIC CASCADES: FIRM EVIDENCE FROM CHANNELLING EXPERIMENTS. Chadderton, L. T.; Johansen, A.; Sarholt-Kristensen, L.; Steenstrup, S.; Wohlenberg, T. (Univ. of Copenhagen). Radiat. Eff.; 13: No. 1-2, 75-86(Mar 1972).

The sputtering of single crystals of radioactive gold by well-collimated beams of energetic ions were investigated in detail, using cylindrical collectors. For 80-keV argon ions incident in and near to ⟨100⟩ channels, there is a very sensitive dependence of the height and shape of the ⟨110⟩ spots on angular deviation.

This is shown to be a consequence not only of the size and degree of order within an atomic cascade, but also of its position below the bombarded surface, following ion dechanneling. At angles of incidence such that cascades lie at very shallow depths, the ⟨110⟩ spots develop an internal structure, which is shown not to be an artefact, but can be due to not fully focused collision sequences, from the cascade. Detailed variations in ⟨110⟩ spot structure and relative intensities for beams incident at and near to ⟨110⟩ axial and {100} planar channels are also described, as are the influences of incoming ion energy. (auth)

35269 CLUSTERS SPUTTERED FROM TUNGSTEN. Staudenmaier, G. (Univ., Munich). Radiat. Eff.; 13: No. 1-2, 87-91(Mar 1972).

A polycrystal tungsten target (250°C) was bombarded with 150-keV ions of He, Ne, Ar, Kr, Xe, and Cu (current density 200 μA/cm²). With a mass and energy spectrometer, the mass distribution of the sputtered charged particles was determined in the energy range 10 to 1250 eV. With increasing projectile mass, the yield and the observable size of clusters W_n^+ increased. In the present study, this yield decreased monotonously with increasing n. The maximum cluster size observed was W_{12}^+ during sputtering with Xe^+. The cluster yield decreased steeply with increasing cluster size and cluster energy. The slope of this energy dependence, however, appeared to be independent of the projectile mass. A crude kinetic model based on collision cascades is proposed to account for the cluster formation. (auth)

35270 RUTHERFORD SCATTERING FROM ULTRA-THIN EPITAXIAL FILMS. Dale, E. B.; Poole, G. C.; Oezkoek, S.; Goldberg, H. (Kansas State Univ., Manhattan). Contract AT(11-1)-1766. Radiat. Eff.; 13: No. 1-2, 3-7(Mar 1972).

Experiments were undertaken to determine the feasibility of finding the location of the atoms of a pseudomorphic monatomic layer of silver on a palladium substrate. 200-keV He^{2+} ions are scattered off the palladium substrate before and after coating with an epitaxial silver film, the direction of incidence being along the ⟨100⟩ and ⟨110⟩ crystal directions, so that the backscattered yield is reduced by channeling of the He ions. Silver atoms that are aligned with atomic rows along the direction of incidence do not increase the yield of ions backscattered off the surface, whereas atoms that are interstitial to the atomic rows of the substrate do increase the yield. It is concluded that the technique is useful, particularly as an adjunct to LEED and Auger spectroscopy, in the study of film structure. (auth)

35271 MULTIPLE SCATTERING OF CHANNELED IONS IN CRYSTALS. Beloshitskii, V. V.; Kumakhov, M. A.; Muralev, V. A. (Moscow State Univ.). Radiat. Eff.; 13: No. 1-2, 9-22 (Mar 1972).

The Focker–Planck equation for scattering of channeled ions by electrons and thermal vibrations of crystalline lattice atoms was obtained and solved. For calculations, use was made of two models of the electron density distribution in a channel: the Thomas–Fermi model and the free-electron model. Axial and planar channeling was considered. It was shown that scattering by electrons plays an important part in ion dechanneling. In particular, in axial channeling scattering by electrons has a dominant effect on dechanneling of fast light ions. A comparison is made between theory and experiment on dechanneling of fast ions in tungsten and silicon. (auth)

35272 DEPTH DEPENDENCE OF ANGULAR DIPS: MEASUREMENTS AND CALCULATIONS FOR H^+ AND D^+ IN Si AND Ge. Campisano, S. U.; Foti, G.; Grasso, F.; Quercia, I. F.; Rimini, E. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Radiat. Eff.; 13: No. 1-2, 23-31 (Mar 1972).

The variation of shape of angular dips with penetration depth was investigated by the backscattering technique for 0.3- to 1.5-MeV protons and deuterons impinging on Si and Ge single crystals at different temperatures. Since the depth dependence of the angular dips at small depths is unknown, the comparison between the experimental critical angle $\psi_{1/2}$ determined at nonzero penetration and the theoretical values obtained at zero depth is ambiguous. Yield profiles vs penetration depth were thus calculated accounting for the nuclear and electronic reduced multiple scattering. The obtained results justify quantitatively both the magnitude of the experimental data and their dependence on the target temperature, ion energy and penetration depth. The disagreement previously reported between the figures calculated at zero depth and the extrapolated experimental values results from the strong variation of $\psi_{1/2}$ near the crystal surface. (auth)

35273 DECHANNELING OF PROTONS IN NIOBIUM SINGLE CRYSTALS. Behrisch, R. (Oak Ridge National Lab., Tenn.); Scherzer, B. M. U.; Schulze, H. Radiat. Eff.; 13: No. 1-2, 33-42(Mar 1972).

Minimum yield of backscattered protons and H atoms with primary energies of 50 to 150 keV from a well-annealed Nb single crystal was measured in single and double alignment as a function of emerging energy at different temperatures. From these data, minimum yield as a function of depth was calculated, assuming electronic energy losses only. The results are compared to analytical equations for minimum yield in single and double alignment. These equations were obtained from Lindhard's theory of electronic and nuclear multiple scattering in single crystals. It was assumed that transverse energy increases steadily with penetration depth, diffusion being negligible. At higher energies, the agreement between theory and experiment is good in ⟨100⟩ single alignment. In ⟨110⟩ single alignment and at lower energies experimental values are about a factor of 2 higher. In double alignment, there is a discrepancy of nearly one order of magnitude, which probably must be attributed to lattice defects. (auth)

35274 EFFECTS OF THERMAL VIBRATIONS AND IMPURITY ATOMS ON CHANNELING PHENOMENA. Fujimoto, F. (Tokyo Univ.); Komaki, K.; Nakayama, H.; Ishii, M. Radiat. Eff.; 13: No. 1-2, 43-50(Mar 1972).

The temperature dependence of minimum yield and dechanneling coefficient is studied for ⟨110⟩ and ⟨111⟩ axial channeling in germanium and silicon crystals. The observed minimum yield and the dechanneling coefficient are represented by linear relations of the mean square amplitude of thermal vibrations, and the results are compared with theory. For the minimum yield, the observed values are independent of energy and kind of particles and agree with theoretical values. The dechanneling coefficients show a poor agreement with theory. To find a reason for this discrepancy, the critical angle and the theoretical treatment are considered and discussed. A method to obtain the lattice disorder in a crystal doped with impurity atoms by measuring the dechanneling coefficient and minimum yield for protons and helium ions is presented. This method is applied to a silicon crystal containing arsenic atoms. (auth)

35275 DECHANNELING BY STACKING FAULTS AND DISLOCATIONS. Mory, J.; Quere, Y. (Groupe d'Effets des Radiations, Fontenay-aux-Roses, France). Radiat. Eff.; 13: No. 1-2, 57-66(Mar 1972).

The general features of dechanneling by lattice defects are briefly described. The dechanneling cross section of a defect $\bar{A}$ and the opacity of crystal Ω are defined. Stacking faults and dislocations are more specifically studied in the case of planar channeling. At a stacking fault, the potential valleys are shifted. The dechanneling cross section is shown to depend linearly on the distance of minimal approach d_a between channelons and planes. A measurement of $\bar{A}$ in the case of α particles and stacking faults in Au then gives the following values for d_a and for $\bar{\chi}$ the dechanneling probability of channelons hitting a fault: T = 4.2°K; $d_a = 0.9a_{T.F.}$; $\bar{\chi} = 0.18$: T = 20°C; $d_a = 1.4a_{T.F.}$; $\bar{\chi} = 0.24$. Near dislocations, the dechanneling is attributed to the distortion of the lattice. In a simple model where the channelon is supposed initially not to oscillate ($E_\perp = 0$), the cross section $\bar{A}$ is found to have a $E^{-1/2}b^{1/2}N_p^{-1/2}$ dependence; E is the energy of the channelon, b the Burgers vector of the dislocation, and N_p the atomic density of the channeling planes. An experimental determination of $\bar{A}$ with α particles in Al yields $\bar{A}$ = 140 Å/u.l. of dislocation to be compared with the theoretical value $\bar{A}$ = 175 Å/u.l. (auth)

35276 EFFECTS OF GAMMA RADIATION ON THE ELECTRIC PROPERTIES OF EPOXY RESIN. Ikejiri, Tadao (Fukui Univ., Japan). Zairyo; 21: No. 220, 45-50(Jan 1972). (In Japanese).

The resistance against electric insulation, the strength against dielectric breakdown, and the resistance against arc were examined. Three kinds of epoxy resins were used: bisphenol, novolac, and cycloaliphatic. The γ dose was prescribed between 10^6 and 10^9 rad. With increasing of γ dose there was a general decrease in insulation resistance. There can sometimes be restoration of insulation resistance by virtue of its temperature dependence. The strength in voltage against dielectric breakdown decreased slowly with increasing of γ dose. The arc resistance of epoxy resin began to drop at exposure to radiation of about 10^8 rad and over, though there can sometimes by epoxy resin that is intact in arc resistance despite exposure to radiation even of about 10^9 rad. When aromatic amine and acid anhydride are used as curing agents for epoxy resin there is but little effect of γ irradiations on its arc resistance. The amount of curing agents consumed by epoxy resin when it shows its maximum arc resistance value, and their amount when epoxy resin shows its minimum value, were examined. (auth) (Japan)

35277 PAIR-PRODUCTION ENERGIES IN SILICON AND GERMANIUM BOMBARDED WITH LOW-ENERGY ELECTRONS. Fiebiger, J. R.; Muller, R. S. (Univ. of California, Berkeley). J. Appl. Phys.; 43: No. 7, 3202-7(Jul 1972).

The pair-production energy E_p for free carriers in silicon and germanium is measured using low-energy electrons (10 to 24 keV) as ionizing sources. The number of carriers generated is measured via a modified Haynes–Shockley technique with a pn junction collector and a superposed drift field. Experimental values for E_p of 2.91 eV in germanium and 3.64 eV in silicon are determined. These results agree quite closely with the predicted values of Klein and Shockley and correspond to values for E_p measured with higher-energy irradiation sources. The result for silicon confirms values for comparable bombardment conditions measured by Norris and Gibbons. The result for germanium is appreciably lower than the average of previously reported E_p values. (auth)

35278 DETERMINATION OF LATTICE DISORDER PROFILES IN CRYSTALS BY NUCLEAR BACKSCATTERING. Ziegler, James F. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys.; 43: No. 7, 2973-81(Jul 1972).

A detailed analysis is presented for the determination of lattice disorder in crystals by nuclear backscattering. By means of models and numerical integration, calculations are performed to determine, as a function of depth, the energy loss of projectiles in crystals, their critical angle for dechanneling, their nuclear elastic scattering cross section, and the effects of lattice disorder on the specific energy loss of channeled ions. These calculations are more detailed than those previously used. The efficacy of the analysis is tested with experiments at 1500 and 2500 keV, and it is shown that these detailed calculations are necessary to extract accurate lattice disorder profiles. The effects of misalignment of the target during channeling experiments are determined. The error introduced by misalignment can be made small. (auth)

Physical Properties

Refer also to abstracts 33192, 33416–33418, 33866, 33913, 33933, 33944–33953, 34768–34770, 34787, 34789, 34803, 34983, and 35199.

35279 (NBS-SPEC. PUBL–323) ELECTRONIC DENSITY OF STATES. Based on Invited and Contributed Papers and Discussion [of the] 3rd Materials Research Symposium, Gaithersburg, Maryland, November 3–6, 1969. Bennett, Lawrence H. (ed.) (National Bureau of Standards, Washington, D. C. Inst. for Materials Research). Dec 1971. 834p. (CONF-691127). GPO $7.75.

Ninety-nine papers are included on band structure, photoemission, many-body effects, soft x-ray, ion-neutralization, disordered systems, electronic specific heat, tunneling, and transport properties. A separate abstract was prepared for each of 19 papers. (M.H.R.)

For abstracts of individual papers see: 34768–34770, 35280–35295.

35280 (NBS-SPEC. PUBL–323, pp 53-6) CALCULATION OF DENSITY OF STATES IN W, Ta, AND Mo. Petroff, I.; Viswanathan, C. R. (California Univ., Los Angeles. Dept. of Electrical Sciences and Engineering). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

Density of states curves were calculated for tungsten, tantalum, and molybdenum from corresponding energy band structures obtained by a nonrelativistic APW (augmented plane wave) calculation. The Fermi energy and the density of states at the Fermi energy were obtained for each material. The calculations were part of a study intended to calculate theoretical photoemission yield curves which could be compared with experimental results. (auth)

35281 (NBS-SPEC. PUBL–323, pp 67-74) CALCULATED EFFECTS OF COMPRESSION UPON THE BAND STRUCTURE AND DENSITY OF STATES OF SEVERAL METALS. Kmetko, E. A. (Los Alamos Scientific Lab., N. Mex.). Dec 1971.

From Symposium on electronic density of states: Gaithersburg, Md. (3 Nov 1969).

Energy bands were obtained self-consistently by the augmented plane wave method for the following metals: Li, Cs, Ca, Sr, Ba, La, Ce, U, Pu, W, Pb, and Fe. The density of states and the electronic charge were resolved into s-, p-, d-, and f-like components. Under compression the charges associated with the higher values of l increase, mainly at the expense of the s-like component, and a more compact overall distribution is thereby achieved. The present results indicate that such electronic transitions are of general occurrence and probably play a significant role in determining the compressibility of metals. (auth)

35282 (NBS-SPEC. PUBL–323, pp 159-61) DENSITY OF STATES AND PHOTOEMISSION FROM INDIUM AND ALUMINUM. Koyama, R. Y.; Spicer, W. E. (Stanford Univ., Calif.). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

Experimental photoemission data from indium and aluminum are briefly described and can be understood in terms of a density of states model. In contrast to this, a direct transition model based on calculated band structures is found to yield photoelectron spectra that are fair reproductions of the density of states. This suggests that, for these two metals, conclusions drawn concerning the density of states are independent of the model used to explain the photoemission data. (auth)

35283 (NBS-SPEC. PUBL–323, pp 199-203) BAND STRUCTURE OF TUNGSTEN AS DETERMINED BY ULTRAVIOLET PHOTOELECTRIC SPECTROSCOPY. Zeisse, C. R. (Naval Electronics Lab. Center, San Diego, Calif.). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

The technique of photoelectron spectroscopy was used to probe the band structure of tungsten in the energy region where the 5d bands are most prominent. The work function of the clean sample, a 25-μ-thick polycrystalline foil, was found to be 4.36 ± 0.02 eV, and the yield rose by three orders of magnitude, from 5.0 to 11.3 eV, without showing prominent structure of any other sort. The electron energy spectra, on the other hand, contain two pieces of reliable structure that are found to increase in energy at the same rate as the exciting photon energy. A simple analysis of the data gives evidence that the density of d states in tungsten consists of a shoulder just below the Fermi level, a peak located about 1.5 eV below the shoulder, and a broad peak which extends at least 7 eV below the Fermi level. (auth)

35284 (NBS-SPEC. PUBL–323, pp 205-8) PHOTOEMISSION STUDIES OF SCANDIUM, TITANIUM, AND ZIRCONIUM. Eastman, D. E. (Thomas J. Watson Research Center, Yorktown Heights, N. Y.). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

Photoemission spectroscopy studies of the hexagonal metals Sc, Ti, and Zr in the range 4 to 11.6 eV resolved d-band structure and determined occupied d-band widths (at ½ maximum) of 1.6, 2.0, and 2.3 eV, respectively. Resolved structure for all three metals correlates with structure in energy-band density of states: however, the observed band widths for Ti and Zr are much narrower than previously calculated band widths. The relation of the data to the controversy concerning the nature of optical excitations in transition and noble metals (direct vs nondirect transitions) is discussed. (auth)

35285 (NBS-SPEC. PUBL–323, pp 209-15) PHOTOEMISSION AND REFLECTANCE STUDIES OF THE ELECTRONIC STRUCTURE OF MOLYBDENUM. Kress, K. A.; Lapeyre, G. J. (Montana State Univ., Bozeman. Dept. of Physics). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

Normalized energy distributions of photoemitted electrons for $4.3 < h\nu < 11.8$ eV (threshold is 4.3 eV) and near-normal reflectance for $0.5 < h\nu < 11.8$ eV were measured for molybdenum films prepared with ultrahigh vacuum. The nondirect transition model with constant matrix elements was found to be consistent with the photoemission data. The above model, in conjunction with calculations for the emission of scattered electrons, was used to obtain the optical density of states (ODS) for the occupied states. Three peaks due to d-electrons are observed at $E - E_F = -0.5$, -1.6, and -3.9 eV where E_F is the Fermi energy. No structure is observed for $E - E_F > 4.3$ eV. The imaginary part of the dielectric constant, ϵ_2, is obtained by Kramers–Kronig analysis, and the occupied ODS are used to obtain the ODS for $0 < E - E_F < 4.3$ eV. The latter analysis is done by writing the finite-difference approximation for the integral expression of ϵ_2 and solving for the empty ODS. The ODS is compared to the band calculations of Mattheiss where a molybdenum density of states is obtained by scaling his tungsten (W) results. Both the measured and calculated occupied densities of states have three peaks and both empty states have one dominant peak. The calculations predict a low density of states for $-1 < E - E_F < 0$ eV, which is not observed in the data. The absorption coefficient has a minimum at 11.3 eV which correlates with a dip in the quantum yield. The energy distributions of the photoemitted electrons show small structural changes above the spectral range of the peak in the energy loss function at 10.8 eV. The relation of these data to the explanations based on the electron density of states for the anomalous isotopic mass dependence of the superconducting transition temperature is discussed. (auth)

35286 (NBS-SPEC. PUBL–323, pp 217-23) ULTRAVIOLET AND X-RAY PHOTOEMISSION FROM EUROPIUM AND BARIUM. Broden, G.; Hagstroem, S. B. M.; Heden, P. O.; Norris, C. (Chalmers Tekniska Hogskola, Goteborg (Sweden)). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

Europium and barium are predicted to have very similar outer electronic structures with the exception that europium has a partially filled 4f shell. Measurements are reported on photoemission from thin films excited with both vacuum-ultraviolet and soft x-ray radiation. The results obtained using low-energy excitation indicate the similarity of the materials. Both show structure close to the leading edge in agreement with band-structure calculations that indicate an increase in the density of states immediately below the Fermi level. Only a very small feature is observed with europium films that can be associated with the 4f electrons. On the other hand, using soft x-ray excitation, a large peak corresponding to 4f states lying 2.5 eV below the Fermi level is observed. The difference in the magnitudes is attributed to the size of the matrix elements involved. (auth)

35287 (NBS-SPEC. PUBL–323, pp 557-63) DENSITY OF STATES INFORMATION FROM LOW TEMPERATURE SPECIFIC HEAT MEASUREMENTS. Beck, P. A.; Claus, H. (Illinois Univ., Urbana). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

The calculation of one-electron density-of-state values from the coefficient γ of the term of the low-temperature specific heat linear in temperature is complicated by many-body effects. In particular, the electron–phonon interaction may enhance the measured γ as much as twofold. The enhancement factor can be evaluated in the case of superconducting metals and alloys. In the presence of magnetic moments, additional complications arise. A magnetic contribution to the measured γ was identified in the case of dilute alloys and also of concentrated alloys where parasitic antiferromagnetism is superimposed on an overall ferromagnetic order. No method has as yet been devised to evaluate this magnetic part of γ. The separation of the temperature-linear term of the specific heat may itself be complicated by the appearance of a specific heat anomaly due to magnetic clusters in superparamagnetic or weakly ferromagnetic alloys. (auth)

35288 (NBS-SPEC. PUBL–323, pp 565-8) ELECTRONIC DENSITY OF STATES DETERMINED BY ELECTRONIC SPECIFIC HEAT MEASUREMENTS. Mamiya, T.; Masuda, Y. (Nagoya Univ. (Japan). Dept. of Physics). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

Superconducting transition temperatures, electronic specific heats, and Debye temperatures were recently measured for the 5d transition-metal alloy series Ta–Re. By making use of these data and the theoretical predictions by McMillan, the electron–phonon coupling constant and bare electronic density of states were deduced. The density of states is compared with the theoretical one derived from band-structure calculations of Ta using the augmented-plane-wave (APW) method by Mattheiss. (auth)

35289 (NBS-SPEC. PUBL–323, pp 571-7) LOW-TEMPERATURE SPECIFIC HEATS OF HEXAGONAL CLOSE-PACKED ERBIUM–THULIUM ALLOYS. Satya, Akella V. S.; Wei, Chuan-Tseng (Michigan State Univ., East Lansing). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

The specific heats of hcp erbium and thulium metals and three of their isostructural alloys were measured in the liquid-helium temperature range between 1.3 and 4.2°K for examining the validity of the localized 4f-band model, on which the current theories of the rare-earth metals are based. Barring possible uncertainties in the magnetic properties of the samples and their impurity contents, the coefficients of the specific-heat component, linear in temperature, calculated from the present data range in values approximately two to twenty times the constant electronic specific-heat coefficient predicted by the above model for all the hcp rare-earth lanthanides. Possible explanations for such discrepancies are discussed. An itinerant 4f-band model based on the one-electron-band model suggested by Mott is proposed for the lanthanides as an alternative to the localized 4f-band model. (auth)

35290 (NBS-SPEC. PUBL–323, pp 587-96) DENSITY OF STATES OF TRANSITION-METAL BINARY ALLOYS IN THE ELECTRON-TO-ATOM RATIO RANGE 4.0 TO 6.0. Collings, E. W.; Ho, J. C. (Battelle Memorial Inst., Columbus, Ohio). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

Using Ti–Mo as a prototype of binary bcc transition metal alloys for $4 < e/a < 6$, densities-of-states at the Fermi level, $n(E_F)$, were studied using low-temperature specific heat augmented by magnetic susceptibility (χ) measurements. A survey of the literature has revealed that the principal descriptors of density of states, γ (the electronic specific heat coefficient), and T_c (the superconducting critical temperature), generally decrease as e/a decreases below about $e/a \sim 4.3$ to 4.5. The maxima in γ and T_c so induced have usually been interpreted as indicating the existence of maxima in $n(E_F)$ near $e/a \cong 4.5$ for bcc alloys. But since the region $e/a \lesssim 4.5$ also corresponds to that in which a submicroscopic hexagonal-structured precipitate (ω phase) always appears in quenched alloys, a detailed study of microstructure was undertaken in conjunction with the electronic property measurements. It was concluded that steadily increasing abundance of an ω-phase precipitate was responsible for the observed drops in γ, T_c, and χ below $e/a \cong 4.5$. Because of the fineness of the precipitate (70 to 330 Å) the physical property results themselves are indistinguishable from those usually associated with single-phase materials. Using magnetic susceptibility at elevated temperatures, where the prototype Ti–Mo alloy is known to be single-phase bcc, it was shown that $n(E_F)_{bcc}$ increases monotonically as e/a is reduced from 6 to 4, in agreement with deductions based on the results of recent band-structure calculations on bcc 3d transition metals. (auth)

35291 (NBS-SPEC. PUBL–323, pp 659-63) ROLE OF EXCHANGE EFFECTS ON THE RELATIONSHIP BETWEEN SPIN SUSCEPTIBILITY AND DENSITY OF STATES OF DIVALENT METALS. Jena, P. (Utah Univ., Salt Lake City. Dept. of Physics); Das, T. P.; Mahanti, S. D.; Gaspari, G. D. Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

The influence of exchange and correlation of conduction electrons on the spin susceptibility, χ_s, is well understood in alkali metals. There is reasonable agreement between theoretical and experimental results where the latter are available. No such comparison was reported for the divalent metals, mainly because of a lack of experimental information. Only for Be is χ_s known (from spin resonance measurements). Semi-empirical estimates of χ_s were made for Mg and Cd by adjusting the measured Knight shifts with theoretical values of the core polarization and $\langle\psi^2(0)\rangle$. The values of χ_s so deduced are compared to theoretical estimates made by the method of Silverstein, who treated the exchange enhancement by an interpolation procedure analogous to that of Nozières and Pines for calculating correlation energies, and included the effects of band structure through the calculated thermal (band) effective mass. Agreement is good for Mg, which behaves more like a free-electron metal, and poor for Be and Cd. Possible sources of the discrepancies are discussed. (auth)

35292 (NBS-SPEC. PUBL–323, pp 673-80) TUNNELING MEASUREMENTS OF SUPERCONDUCTING QUASI-PARTICLE DENSITY OF STATES AND CALCULATION OF PHONON SPECTRA. Rowell, J. M. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

It is an unfortunate fact that the tunneling technique, which has proved incredibly successful in the study of superconductivity, has given little information about the normal state properties of metals and semiconductors. It is shown that, in the determination of the superconducting quasi-particle density of states, it is the change in density induced by the onset of superconductivity which is measured rather than the total density. Returning to the problem of normal materials, a review of the limited achievements and failures of tunneling is presented. This will include the influence of band edges on tunneling in p-n diodes and metal-semiconductor contacts, the structures observed in tunneling into bismuth and the negative results obtained in nickel and palladium. The dominant effect of the change in barrier shape in most of these tunneling characteristics will be illustrated. (auth)

35293 (NBS-SPEC. PUBL–323, pp 681-4) DENSITY OF STATES FROM SUPERCONDUCTING CRITICAL FIELD MEASUREMENTS. Dummer, G.; Mapother, D. E. (Illinois Univ., Urbana). Dec 1971.

From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

For a superconducting metal the entropy difference, ΔS, between the normal and superconducting states is thermodynamically related to the critical field, H_c, by the equation $\Delta S = S_n - S_s = 1$ $(VH_c/4\pi)(dH_c/dT)$, where V is the molar volume and T is the absolute temperature. As the temperature approaches 0°K, it can be shown that ΔS is dominated by the normal electronic entropy, γT, where γ is the temperature coefficient of the normal electronic specific heat. This behavior has been known for a long time but its application has been largely confined to inferences based on conjectural extrapolations of H_c data measured about 1°K. In the limit of very low temperatures where $\Delta S = \gamma T$, it follows that $H_c^2(T) = H_0^2 - (4\pi\gamma/V)T^2$, where H_0 is the limiting value of H_c at 0°K. For most superconductors the range of validity of this expression lies below 1°K, but new techniques have made this range relatively accessible in recent years. Within this range precise static measurements of H_c and T permit determination of the ratio, $\gamma^* = (\gamma/V)$, with a relative accuracy of about 1: 3000. This is considerably better than the accuracies typically obtained in low-temperature calorimetry. This method was used to study the change in γ^* under hydrostatic pressures up to 1000 atm for In and Tl. Nonlinear changes in γ^* are clearly resolved for the first time, despite the relatively low values of applied pressure. For In the values of γ^* show a parabolic decrease with increasing pressure. The results for Tl show an initial increase in γ^*, which reaches a maximum near p = 500 atm. For larger pressures, the value of γ^* shows the normal decrease with increasing p. (auth)

35294 (NBS-SPEC. PUBL–323, pp 685-91) TEMPERATURE DEPENDENCE IN TRANSPORT PHENOMENA AND ELECTRONIC DENSITY OF STATES FOR TRANSITION METALS. Shimizu, M. (Nagoya Univ. (Japan). Dept. of Applied Physics). Dec 1971.
From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

The calculated results of the temperature variations of electronic specific heat and spin susceptibility and their comparison with the experimental results for various transition metals are briefly summarized. In these calculations the empirical densities of states, determined in the rigid band model from the experimental data of low-temperature specific heat coefficients, were made use of. In a model similar to the Mott model of s–d scattering, the electrical resistivity, thermal conductivity, and thermoelectric power were calculated at high temperatures for palladium, platinum, rhodium, iridium, molybdenum, and tungsten, by assuming appropriate electronic structures and making use of the same empirical densities of states. The calculated temperature dependences of electrical resistivity, thermal conductivity, and thermoelectric power and the sign of the thermoelectric power at high temperatures are found to be strongly dependent on the shape of the density of states and the position of the Fermi level. It is shown that all of these temperature dependences and the sign of the thermoelectric power are consistent with the experimental results. It is confirmed that there is a strong correlation between these temperature dependences and those of the electronic specific heat and spin susceptibility. (auth)

35295 (NBS-SPEC. PUBL–323, pp 717-25) EFFECT OF HYDROSTATIC PRESSURE ON THE GALVANO-MAGNETIC PROPERTIES OF GRAPHITE. Spain, I. L. (Maryland Univ., College Park. Inst. for Molecular Physics). Dec 1971.
From Symposium on electronic density of states; Gaithersburg, Md. (3 Nov 1969).

Measurements of the Hall effect and magnetoresistance in crystals of graphite with current flow in the basal planes at high pressures are described. Galvanomagnetic measurements enable the magneto conductivity tensor components σ_{xx} and σ_{xy} to be obtained, and from them the electron and hole densities and mobilities. The results are compared with the band model for the semi-metal graphite proposed by Slonczewski and Weiss. Of particular interest at the present time is the information that these results give about the assignment of carriers at the symmetry point K in the Brillouin zone of graphite and the properties of mobile minority carriers. (auth)

35296 ACTIVE ELEMENTS OF A FILM ARRANGEMENT. Bogdan, G. I. (Kiev Polytechnic Inst.). Poluprov. Tekh. Mikroelektron.; No. 5, 51-6(1971). (In Russian).

The basic properties of the negative resistance of S- and N-type of junctions were examined in a $Nb/Nb_2O_5/In$ junction. Volt–ampere characteristics were measured at −100, 20, and 100°C. A mechanism is proposed for the phenomena observed. (tr-auth)

35297 THERMAL EMISSION PROPERTIES OF GROUP VI TRANSITION METAL BORIDES. Samsonov, G. V.; Fomenko, V. S.; Kunitskii, Yu. A. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 7, 1239-40(Jul 1971).
Translated from Radiotekh. Elektron.; 16: No. 7, 1304(Jul 1971).

The thermal emission properties of Cr_4B, Cr_3B_2, CrB, Cr_3B_4, CrB_2, Mo_2B_5, and W_2B_5 were studied. Results show that the work function ϕ_0 decreases as one goes from W_2B_5 to Mo_2B_5 and CrB_2, and along the series $CrB_2 \rightarrow Cr_3B_4 \rightarrow CrB \rightarrow Cr_3B_2 \rightarrow Cr_4B$ of the chromium borides. It was concluded that for Cr–B systems, the increase in the work function in the direction $Cr_4B \rightarrow CrB_2$ is the result of localization of electrons in the B–B bonds. The assumptions concerning the changes in the number of interatomic bonds is well confirmed by certain trends observed in the changes of certain physical properties that characterize the strength of the crystal lattice. Data are tabulated. (P.C.H.)

35298 ELECTRICAL PROPERTIES OF A NIOBIUM OXIDE FILM. Nekrasov, M. M.; Bogdan, G. I. (Kiev Polytechnic Inst.). Poluprov. Tekh. Mikroelektron.; No. 5, 33-7(1971). (In Russian).

The volt–ampere characteristics of a Nb_2O_5 film in the structure $Nb/Nb_2O_5/Me$ were investigated. The height of the potential barrier at the boundary of the dielectric and metal, and the value of the electron affinity of Nb_2O_5 were determined. The capacity of thin films as a function of constant bias was measured, and the presence of a p–i–n junction in the oxide film was confirmed. (K.S.W.)

35299 REMARKS ON THE ELECTRONIC STRUCTURE OF RARE-EARTH INTERMETALLICS. Gomes, A. A. (Paris Univ., Orsay, France). Phys. Lett.; 39A: No. 2, 139-40(24 Apr 1972).

A model is given for the electronic structure of RFe_2 and RCo_2 intermetallics in terms of s and d bands. (auth)

35300 NEW METHOD OF INVESTIGATION OF ELECTRON STRUCTURE IN METAL SURFACES WITH THE AID OF POSITRON ANNIHILATION. Dekhtyar, I. Ya.; Silantev, V. I. (Inst. of Metal Physics, Kiev). Phys. Status Solidi (a); 10: No. 2, 657-66(16 Apr 1972).

A method is given for the investigation of momentum distribution of γ-quantum annihilation from the metal surfaces. The method uses the interaction between positronium atoms and surface atoms. Possible mechanisms of this interaction are discussed and the conditions under which the method may be applied are defined. The method was used for the investigation of the momentum distribution of photon annihilation from the surface of polycrystalline iron and aluminum, and single-crystalline molybdenum. It is shown that this distribution is parabolic for Fe and Al and differs significantly from the conduction-electron distribution in the bulk metal. For Mo crystals, it was concluded that there are two states for electrons on the surface of the (100) plane. It is assumed that the experimental definition of the electron density gradient on the metal/vacuum interface may serve as a criterion which allows one to estimate some physical properties of metal and alloy surfaces. The possibilities of the new method are discussed. (auth)

35301 ELECTRIC AND HEAT CONDUCTIVITY OF RHENIUM, OSMIUM, IRIDIUM, AND SOME OF THEIR ALLOYS WITH THORIUM AND LANTHANUM WITHIN WIDE RANGE OF TEMPERATURES. Gugnin, A. A.; L'vov, S. N.; Mal'ko, P. I.; Nemchenko, V. F.; Starodubov, I. P. (Kherson Pedagogical Inst., USSR). Porosh. Met., Akad. Nauk Ukr. SSR; No. 1, 65-70(Jan 1972). (In Russian).

The temperature dependence of electric resistance and heat conductivity of Re, Os, Ir, and the alloys Re + 6% by weight Th, Os + 6% by weight Th, and Ir + 6% by weight La was investigated within a wide range of temperatures. The electric resistance of Os increased linearly with the temperature growth. In Re and Ir considerable deviations were observed from linearity at high temperatures. Heat conductivity of all three metals decreased with an increase of temperature. Alloys possessed higher resistance and reduced heat conductivity as compared with corresponding metals. Slight deviations from the Matthiessen rule were observed. (auth)

35302 STUDY OF THE MIXED MONOSULPHIDES OF URANIUM AND THORIUM. Griveau, B.; Marcon, J.-P.; Gatescoupe, J.-P. (CEN, Fontenay-aux-Roses, France). J. Inorg. Nucl. Chem.; 34: No. 5, 1535-9(May 1972). (In French).

The mixed sulphides (U, Th)S were prepared and their low-temperature resistivity and magnetic susceptibility studied. In view of the large measure of disagreement in the literature, a precise study was made of the variation in the lattice parameter with the U/Th ratio and the impurity (oxygen) content. The results are discussed in relation to the magnetic and electronic properties of the mixed sulphides. (tr-auth)

35303 MAGNETIC CRYSTAL ANISOTROPIES OF HOLMIUM–ERBIUM ALLOYS. Bozorth, R. M.; Clark, A. E.; Van Vleck, J. H. Int. J. Magn.; 2: No. 2, 19-31(Jan 1972).

Magnetization curves were measured for single crystals of hexagonal holmium, erbium, and their solid solutions with each other (at 12.5% intervals) in their three principal crystallographic directions. The anisotropy is determined by measuring the energy $\int_0^{M_s} HdM$ for each of the principal directions in spherical crystals of each composition. The results show the inversion of the anisottropy energy at the composition HoEr; the maximum anisotropy is about 2×10^8 ergs/cm^3 for both Ho and Er. Some of the experimental results are discussed theoretically. The difference in sign of the anisotropy of pure Ho and pure Er is explicable on the basis of simple crystal-field theory, as is the absence of appreciable anisotropy in HoEr. A combination of crystal- and molecular-field theory accounts semiquantitatively for the work required to magnetize HoEr to saturation. Reasons are presented to show that the Curie temperature of HoEr is considerably higher than that of pure Ho or Er. (auth)

35304 INTERPRETATION OF THE MAGNETOSTRICTION OF RARE EARTH METALS SINGLE CRYSTALS IN THE PARAMAGNETIC REGION. Boutron, P. (CNRS, Grenoble, France). J. Phys. Chem. Solids; 33: No. 5, 1005-15(May 1972).

Expressions are determined for the magnetostriction of a magnetic crystal above the ordering temperature in terms of the exchange coefficients and of the crystalline potential parameters. By interpreting the basal-plane magnetostriction results, the corresponding crystalline potential parameter is deduced and compared with the value calculated from the point-charge model. The derivatives of exchange vs the crystal parameters are obtained: the anisotropy of exchange interaction appears to be important. (auth)

35305 PHYSICS OF RARE EARTH SOLIDS. Taylor, K. N. R.; Darby, M. I. London; Chapman and Hall, Ltd. (1972). 318p. Pounds 7.

The subject is dealt with in sections; ionic properties (theory of free ions, free ions in a magnetic field, ions in crystals, electron spin resonance, spin lattice relaxation, spin—spin interactions, magnetic susceptibilities, specific heats), structural behavior of the rare earth metals and alloys (crystal structures of the pure metals, structural stability, discussion of the structural behavior, elastic properties), band structures (symmetry considerations and free-electron theory, nonrelativistic methods of band structure calculation, results of nonrelativistic APW calculations, the relativistic augmented plane wave method, relativistic calculations for the heavy rare earths, positron annihilation experiments), magnetic properties (RKKY interaction, bulk magnetic properties, theory of the ordered states, spin waves, hyperfine interactions), transport properties (electrical resistivity, spin-disorder resistivity, spin-wave scattering, the effect of superzone boundaries, resistivity above the ordering temperature, effects of alloying and pressure, Hall effect, thermal conductivity, thermoelectric properties), and rare earth compounds (rare earth oxides, compounds formed with sulphur, selenium, and tellurium, compounds with group V elements, rare earth-aluminum compounds, rare earth-transition metal compounds, noble metal compounds, compounds with elements of group IV A). (UK)

35306 SOFT X RAY SPECTROSCOPY AND THE ELECTRONIC STRUCTURE OF SOLIDS. Fabian, D. J.; Watson, L. M.; Marshall, C. A. W. (Univ. of Strathclyde, Glasgow). Rep. Progr. Phys.; 34: No. 7, 601-96(1971).

Electronic transition processes accompanying the emission and absorption of soft x radiation are discussed, and elementary band structure relevant to the interpretation of soft x-ray spectra is reviewed. The importance of many-body effects is emphasized and the relative importance of Auger and instrumental broadening examined. (auth)

35307 STUDY OF THE ELECTRICAL PROPERTIES OF ZIRCONIA HEATERS AT TEMPERATURES UP TO 2100°C. Rutman, D. S.; Taksis, G. A.; Maurin, A. F.; Toropov, Yu. S. Refractories (USSR) (Engl. Transl.); 12: No. 7-8, 518-22 (Jul-Aug 1971).

Translated from Ogneupory; 12: No. 8, 41-5(Aug 1971).

With a change in the electrical load on the heating element, causing a change in the temperature by 150 to 300°C, the thermal equilibrium of the system is stabilized for the specified furnace design in a period of 1 h. The electrical resistance in this case drops smoothly, asymptotically approximating values typical for equilibrium conditions. The rating on the heating element at the moment of raising the current strength increases, and then drops smoothly as a function of the change in the resistance of the heater. The temperature at the surface of the element changes as a function of the current density in a relation nearly linear, independently of the nature of the stabilizing additive. The heating element containing cerium oxide is distinguished by a relatively low rating compared with the elements containing CaO and Y_2O_3, but the nonlinearity of the relationship with temperature and the rating makes its use less desirable as a result of the great complexity of control. The volt—ampere characteristics suggest that the control of the working cycle of the heating element should be made with respect to the current strength, which will ensure the possibility of controlling the heating elements based on zirconium dioxide which are characterized by a negative temperature coefficient of resistance. (auth)

35308 EMISSION OF OXIDE CATHODES IN A STRONG LONGITUDINAL MAGNETIC FIELD. Rutshteyn, S. Radio Eng. Electron. Phys. (USSR) (Engl. Transl.); 16: No. 4, 710-12(Apr 1971).

Translated from Radiotekh. Elektron.; 16: No. 4, 648-50(Apr 1971).

The use of a longitudinal magnetic field to measure the true emission current density for rough, extended emitter surfaces was studied using pulsed magnetic fields of 80 kG. The pulsed volt—ampere characteristics were measured with electric field pulses in the absence and presence of the magnetic field. Above the space-charge region, the cathode current falls with the magnetic field. Effects of cathode density were studied. The results show that even the 80-kG field does not lead to complete saturation of the emission vs field dependence. (D.L.C.)

35309 EFFECT OF DISSOLVED HYDROGEN ON THE ELECTRICAL AND MAGNETIC BEHAVIOR OF $PrCo_2$ AND $NdCo_2$. Titcomb, C.; Draig, R. S.; Wallace, W. E.; Rao, V. U. S. (Univ. of Pittsburgh). Phys. Lett.; 39A: No. 3, 157-8(8 May 1972).

When retained hydrogen is removed from $PrCo_2$ and $NdCo_2$, these compounds remain paramagnetic to temperatures well below their normal Curie temperatures. Abstraction of the hydrogen seems to weaken exchange, depressing T_c by about 40° for $PrCo_2$ and 110° for $NdCo_2$. (auth)

35310 INFLUENCE OF A MAGNETIC FIELD ON THE HYDROGEN EQUILIBRIUM PRESSURE OF RCo_5H_x. Kuijpers, F. A. (Philips Research Labs., Eindhoven, Netherlands). Phys. Lett.; 39A: No. 3, 240-2(8 May 1972).

The hydrogen equilibrium pressure above a two-phase mixture $RCo_5H_x + RCo_5H_y$ (R = La or Nd) can be changed slightly by applying a magnetic field. For H = 10 kOe, a relative change $\Delta p/p \approx 6 \times 10^{-3}$ was measured for R = La, x = 3.35, y = 4.3, T = 295°K. (auth)

35311 HALL AND DRIFT MOBILITY IN V_2O_5 SINGLE CRYSTALS. Vinogradov, A. A.; Shelykh, A. I. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2781-5(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3310-15(Nov 1971).

The electrical properties of V_2O_5 crystals were studied over the following temperature ranges: electrical conductivity σ, −120 to 630°C; Hall effect, −120 to 320°C; and the thermal emf α, 30 to 600°C. The electrical conductivity and the Hall effect were measured under dc and ac conditions by integral and differential methods. The signs of the Hall constant and the thermo-emf correspond to electron conductivity. The Hall mobility μ_H at 20°C was 10^{-2} to 10^{-1} cm^2/V · sec and decreased as the temperature increased. The Hall effect at $2 \cdot 10^5$ Hz was found to be $\mu_H < 1$ cm^2/V · sec. The carrier drift mobility determined from σ and α was also less than 1 cm^2/V · sec. It decreases over the range 30 to 460°C and at T > 460°C it becomes constant. (auth)

35312 MAGNETIC PROPERTIES OF $V_2O_{3+\delta}$ SINGLE CRYSTALS. Zubkov, V. G.; Matveenko, I. I.; Tallerchik, B. A.; Gel'd, P. V. (Inst. of Chemistry, Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2885-6(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3426-8(Nov 1971).

The magnetic susceptibility of $V_2O_{3+\delta}$ single crystals was measured on a pendulum balance according to the Faraday method in fields up to 16 kOe and in the temperature range from 80 to 300°K. Results showed that as the sample became more nonstoichiometric there was an increase in the specific magnetic susceptibility of the "metallic" phase and a reduction in the phase-transition temperature. It was found that the polytherms $\chi(T)$ in the "metallic" phase are parallel to each other indicating that the effective magnetic moment is independent of the composition. It was also noted that on samples of composition $V_2O_{3.004}$, for $T < T_p$ the anisotropy of $\chi_{||}$ and $\chi_{\perp}$ can be observed confirms the existence of magnetic ordering in the "semiconducting" phase. (D.H.M.)

35313 ANOMALY IN THE VELOCITY OF ULTRASOUND IN GADOLINIUM NEAR THE CURIE POINT. Andreeva, L. P.; Zinov'eva, G. P.; Gel'd, P. V. (Ural Polytechnic Inst., Sverdlovsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2896-8(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3435-8(Nov 1971).

The velocity of propagation of longitudinal and transverse ultrasonic vibrations in a pure sample of polycrystalline gadolinium was studied. Results show that the curve of velocity of longitudinal and transverse waves (at ~10 MHz) versus temperature exhibit pronounced anomalies near the phase transition point. In this case, velocity minima are observed at 288.9 ± 0.5°K. (D.H.M.)

35314 EFFECT OF AN INHOMOGENEOUS ELECTRIC FIELD ON CHANGING THE YTTERBIUM AND NEODYMIUM EQUILIBRIUM COVERAGE OF A TUNGSTEN (111) SURFACE. Marinova, Ts. S.; Glebova, I. B. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2908-9(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3445-6(Nov 1971).

Experiments show that the electron and ion emission fields affect differently the adsorbate distribution both for Yb and Nd. An ion emission field of the same magnitude as an electron emission field effects practically no change in equilibrium coverage, so the magnitude of the applied ion emission field exceeded that of the electron emission field. Two maxima for Yb and one for Nd are observed. These are observed for the same coverages at which "shelves" were observed in the curves of desorption field vs coverage. Evidently this indicates that discrete structures of Yb atoms and Nd atoms form at the W(111) boundaries and, as a result of interactions among the atoms, the magnitude of the dipole moment induced by backing changes significantly. (D.H.M.)

35315 MEAN FREE PATH OF CURRENT CARRIERS IN MOLYBDENUM. Boiko, V. V.; Gasparov, V. A. (Physical-Technical Inst., Sukhumi, USSR). Metallofizika; No. 37, 11-15 (1971). (In Russian).

The amplitude dependence of lines of rf dimensions of the effect arising in the central cross sections of the Fermi surface of Mo was studied as functions of thickness and temperature of the samples. Measurements were made in the region of 1.5 to 18°K. The average free path of current carriers in Mo was determined for different groups of carriers, and their respective contributions to the scattering mechanisms were studied. The temperature-dependent portion of the electron scattering probability in Mo was proportional to T^2. The data obtained were compared with results from the study of the temperature dependence of the statistical conductivity of the metal. (tr-auth)

35316 ELECTRICAL AND THERMAL CONDUCTIVITIES OF TRANSITION METALS OF THE IV AND VI GROUPS IN THE TEMPERATURE RANGE 20 TO 1200^{0}C. L'vov, S. N.; Mal'ko, P. I.; Nemchenko, V. F. (Kherson Pedagogical Inst., USSR). Metallofizika; No. 37, 22-9(1971). (In Russian).

The temperature dependences of the electrical resistance and the thermal conductivity of Ti, Hf, Zr, V, T_a, Nb, Cr, W, and Mo were determined in the temperature interval 300 to 1,500°C. The values of these parameters varied periodically from metal to metal. The temperature dependence of the electrical resistance was nonlinear, and deviations from linearity were attributed to a dependence of the Debye temperature on thermal expansion of the lattice, and to a low placement of the Fermi levels in the generalized s-d zone. The Lorentz number for the majority of metals was lower than the theoretical. The Wiedemann-Franz law applied in a qualitative fashion only. (tr-auth)

35317 DIFFUSION OF IRON AND COBALT ALONG THE GRAIN BOUNDARIES OF TUNGSTEN. Tyshkevich, V. M. (Inst. of Metal Physics, Kiev). Metallofizika; No. 37, 58-60 (1971). (In Russian).

Boundary diffusion of Fe was studied in Co and W by a radioisotope method. At low temperatures diffusion proceeded along the grain boundaries. A comparison was made with the literature data on the boundary self-diffusion of W. (tr-auth)

35318 INFLUENCE OF THE CONCENTRATION OF EXCESS VACANCIES ON DIFFUSION ALONG GRAIN BOUNDARIES. Larikov, L. N.; Shmatko, O. A. (Inst. of Metal Physics, Kiev). Metallofizika; No. 37, 63-5(1971). (In Russian).

Using the alloy Co-31.89% W, the effect of the cooling rate on the aging process was investigated. The growth rate of eutectoid-like cells which formed during decay of supersaturated solutions of W in Co increased with accelerated cooling of the alloy before isothermal annealing. The concentration of the excess vacancies was reflected in the diffusion rate along the grain boundaries. (tr-auth)

35319 BAND STRUCTURE AND DENSITY OF STATES IN HEXAGONAL BN. Nakhmanson, M. S.; Smirnov, V. P. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 11, 2763-8(May 1972).

Translated from Fiz. Tverd. Tela; 13: No. 11, 3288-94(Nov 1971).

Using the orthogonalized-plane-waves (OPW) method, the band structure of BN_{hex} along all the symmetry directions in the Brillouin zone was calculated. Using a previously described approximation procedure, the curve of the density of states N(E) for the valence bands of BN_{hex} was constructed. The density of states for the conduction band was qualitatively sketched. A feature of the band structure of BN_{hex} is the localized plane form of E(k) at the lateral face of the prism of the Brillouin zone. This feature leads to the emergency of narrow and strong peaks in N(E) which are due to the above region of the Brillouin zone. The density-of-states curves N(E) are compared with the x-ray emission and absorption spectra of boron and gold in BN_{hex}. It is concluded that the features of the x-ray spectra correspond to Van Hove singularities in the density-of-states curves. (24 references) (auth)

35320 FERMI SURFACE GEOMETRY AND THE ANTIFERROMAGNETIC PHASE OF EUROPIUM METAL. Greene, Michael P. (Univ. of Maryland, College Park); Kiwi, Miguel. Solid State Commun.; 10: No. 8, 717-19(15 Apr 1972).

In terms of the usual RKKY indirect exchange interaction, the spiral antiferromagnetic phase of europium cannot be attributed to a "nesting" of opposite faces of the tetracube portion of the Fermi surfaces. (auth)

35321 RADIO-FREQUENCY SIZE EFFECT IN CYLINDRICAL INDIUM SAMPLES. Tsoi, V. S. (Inst. of Solid State Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 15: No. 5, 171-2(5 Mar 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 5, 246-7(5 Mar 1972).

Results are presented of measurements of the impedance of single-crystal cylindrical indium samples as a function of the magnetic field. The sample was placed inside the inductance coil of the tank circuit of an rf oscillator in such a way that the rf currents flowed around the cylinder in an azimuthal direction; the generation frequency deviation and its variation were determined. A diagram is given. (M.O.W.)

35322 LATTICE DYNAMICS OF PYROLYTIC GRAPHITE. Nicklow, R.; Wakabayashi, N.; Smith, H. G. (Oak Ridge National Lab., Tenn.). Phys. Rev., B; 5: No. 12, 4951-62(15 Jun 1972).

The frequencies of certain normal modes of vibration of the graphite lattice were studied on samples of high-quality pyrolytic graphite by coherent, inelastic-neutron-scattering techniques. Some of the data are not compatible with certain restrictions imposed by the valence-bond model as presented by Young and Koppel. Therefore, the data were analyzed in terms of a simple axially symmetric Born-von Kármán force-constant model. The results show that appreciable interactions exist between third nearest neighbors in the basal plane. The force model was used to calculate a frequency distribution function and the lattice specific heat of graphite. These calculations are in excellent agreement with the specific heat measured for natural graphite in the temperature range 1.5 to 300°K. (auth)

35323 IMPLANTED INTERSTITIAL BORON ATOMS IN SILICON. Netange, B.; Cherki, M.; Baruch, P. (Univ., Paris). Appl. Phys. Lett.; 20: No. 9, 349-51(1 May 1972).

Photoconductivity methods were used to investigate high-resistivity n- and p-type silicon implanted with doses of $\sim 10^{14}$ B^+/cm^2 of 100 keV. Besides the photoconductivity band associated with the divacancy, a photoconductivity level at ~0.4 eV was detected in the spectrum. This level anneals at ~300°C; it has been associated with boron interstitial atoms in sites of trigonal symmetry for boron-doped silicon irradiated with electrons. The appearance of this level is not so clear in the case of the p-type silicon substrate where the substrate contribution to the photoconductivity is larger. (auth)

35324 DETERMINATION OF THE DIFFUSION COEFFICIENT BY MEANS OF SPONTANEOUS THERMAL ION EMISSION. Riedel, M.; Kaposi, O.; Karacsonyi, R. (Lorand Eoetvoes Univ., Budapest). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Chim.; 12: 207-14(1971).

The activation energy for diffusion of potassium and sodium in tungsten was determined by mass-spectrometric ion-emission measurements. The obtained value of about 30 kcal/moles led to the assumption that a part of the alkali-metal impurities in tungsten are sited along the grain boundaries and their penetration to the surface is prompted by a grain-boundary diffusion. According to the measurements, the determination of the ion emission diffusion coefficient is an adequate method to determine the diffusion coefficient of metals with a low ionization potential in high-melting matrices exhibiting a high work function. (auth)

35325 INVESTIGATIONS ON THE THERMAL ION EMISSION OF TUNGSTEN. Kaposi, O.; Riedel, M.; Karacsonyi, R. (Lorand Eoetvoes Univ., Budapest). Ann. Univ. Sci. Budapest. Rolando Eotvos Nominatae, Sect. Chim.; 12: 179-206(1971).

A method was elaborated for investigating the spontaneous thermal positive ion emission from tungsten by means of a time-of-flight mass spectrometer. The method lends itself to determination of the nature of the ions emitted and also to investigating kinetics of the emission. Temperature and time dependence of the ion emission of not-yet-recrystallized doped and undoped wires and of single-crystal tungsten were investigated. The activation energy of the desorption of alkali metals was calculated and a relation was established between the emission of ions and recrystallization of tungsten. The ion emission from heat-treated, recrystallized wires was investigated in all details and it was found that in this case the ions are emitted mostly in form of ion bursts. Parameters characterizing the ion bursts and the number of the ions that create them were determined. The experimental results, supplemented with a study on the effect that residual gases exert on the ion emission, suggest a uniform conception of the whole emission process. (79 references) (auth)

35326 HALL EFFECT IN TUNGSTEN FILMS INFLUENCED BY HYDROGEN CHEMISORPTION. **Bastl, Z. (Inst. of Physical Chemistry, Prague). Thin Solid Films; 10: No. 2, 311-13(May 1972).**

Hall effect and electric resistivity were measured in 100- to 200-Å films of clean W and W with sorbed H. The H chemisorption produced only a small change in the resistivity but a large change in the Hall coefficient which was linear with the surface coverage. The conductivity mechanism also changes. Some possible explanations are considered briefly. (D.L.C.)

35327 SOME EFFECTS OF STRAIN AND TEMPERATURE ON THE RESISTANCE OF OXYGEN-ION-IMPLANTED TITANIUM THIN FILMS. **Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Thin Solid Films; 10: No. 2, 205-15(May 1972).**

Thin cermet films containing titanium and titanium oxides were produced by implanting oxygen ions into thin titanium films. The effects of temperature and strain on the resistance of these films were studied. Fairly large strain gage factors (>10) were measured and the structures are found to exhibit conduction characteristics similar to discontinuous films. It is further shown that at high temperatures (>250°C), the films increase their resistance irreversibly by over an order of magnitude, and this behavior renders them unsuitable for many strain gage applications. (auth)

35328 DIELECTRIC PROPERTIES OF QUASI-AMORPHOUS THIN LAYERS OF PULVERIZED METALLIC OXIDES. **Perny, G.; Lavielle, L.; Laville Saint Martin, B.; Sarroca, M. (Laboratoire de Physique Appliquee aux Couches Minces, Mulhouse, France). Thin Solid Films; 10: No. 2, 173-83(May 1972). (In French).**

Complex dielectric constants of thin amorphous films are measured for Ta_2O_5 prepared by reactive sputtering in a diode system (cold plasma condensation). The real and the imaginary part of ϵ_1 present a periodic variation with film thickness. These results are similar to those obtained previously for TiO_2. Particular properties in the field of conductivity are obtained for Ta_2O_5. (auth)

35329 INVESTIGATION OF THE APPROACH TO MAGNETIC SATURATION OF COBALT AND NICKEL WITH A STERN–GERLACH EXPERIMENT WITH NEUTRONS. **Nagib, M. (Institut fuer Reine und Angewandte Kernphysik, Kiel). Atomkernenergie; 19: No. 3, 253-8(May 1972). (In German).**

The approach to magnetic saturation of polycrystalline cobalt and nickel was studied with a Stern–Gerlach experiment with neutrons. This method permits the direct measurement of the relative deviation of the magnetization from saturation. The approach to magnetic saturation of the annealed samples follows a $1/(H + (4/3)\ \pi\ M_S)^2$ law in the magnetic field range between 2500 and 25,000 Oe. The theory of approach to magnetic saturation for plastic deformed metals was studied on deformed and annealed polycrystalline nickel. The measured variation of the relative deviation of the magnetization from saturation with the field strength agrees with the theory. With 3 dislocations/dislocation group, the total dislocation density was determined to be $N = (9.5 \pm 3.1) \times 10^9$ cm^{-2} for the 8 kp/mm^2 effective shear-stress sample. The decrease of the dislocation density in the sample with annealing could be identified. The dependence of the polarization cross section for cobalt on the neutron velocity was also measured. (auth)

35330 VARIATIONS IN THE ELECTRICAL CONDUCTIVITY AND THE NATURE OF THE STRUCTURE DEFECTS IN A-TYPE Nd_2O_3. **Wilbert, Yves; Breuil, Helene; Dherbomez, Nicole (Univ., Amiens, France). Compt. Rend., Ser. C; 274: No. 8, 782-5(21 Feb 1972). (In French).**

Increasing oxygen pressure (2.5×10^{-4} to 1 atmosphere) in the 800 to 1200°C temperature range transformed n-type Nd_2O_3 into a p-type semiconductor. A p-type conduction mechanism is proposed. (France)

35331 X-RAY DIFFRACTION ANALYSIS OF SPUTTERED TANTALUM FILMS DURING SECTIONING. **Walker, E. S.; Westwood, W. D.; Livermore, F. C. (Bell-Northern Research, Ottawa). J. Can. Ceram. Soc.; 40: 69-73(1971).**

During the deposition of tantalum films by sputtering onto glass substrates, the conditions under which the films are deposited may change and produce changes in both electrical and structural properties. The crystal structures of tantalum films of different initial thicknesses were investigated by x-ray diffraction as thin layers of the films are successively removed. The lattice constants of β-Ta are found to increase as the films are sectioned by anodization in a barium fluoride electrolyte. When the tantalum thickness is decreased by converting successive layers of the sputtered film to amorphous tantalum pentoxide, in a citric-acid electrolyte, no such change in the lattice constants are observed. The increase in the lattice constants of β-Ta is probably due to the diffusion of fluorine ions into the remaining tantalum film. An oxide layer grown in a citric-acid electrolyte acts as a barrier to fluorine-ion diffusion which occurs when anodizing in a barium fluoride electrolyte. (auth)

35332 RARE EARTHS IN GLASS. **Shutt, T. C. (Colorado School of Mines Research Inst., Golden); Martin, Mary; Lewis, C. J.; Drobnick, J. J. Can. Ceram. Soc.; 40: 29-37(1971).**

The rare earth elements are used in the glass industry as polishing agents and to decolorize or produce subtractive colors or fluorescent properties in glasses. Addition of CeO_2 to glasses can alter the uv absorption properties and prevent discoloration due to high energy x- and gamma radiation. Glasses containing any of the rare earths except Gd_2O_3 have characteristic infrared absorption bands, suggesting uses as optical filters, selective lenses, sunglasses, and other protective glasses. Glass-matrix lasers use Nd, Tb, Dy, Yb, Gd, and Ho as activators. Optical glasses of high refractive index and low dispersion, and photosensitive and phototropic glasses, are made containing the rare earths. Chemical stability, coupled with the electrical conductance properties of many rare-earth glasses, makes them extremely useful for the manufacture of electrodes for chemical applications. Nuclear applications of rare-earth glasses fall into three general categories: radiation absorption (use of high-energy radiation-sensitive glass as a detection device or dosimeter); scintillation (in glass scintillation counters for neutrons and in detection of gamma radiation); and particle absorption (neutron absorption in control rods and burnable poison components for nuclear reactors). (E.M.T.)

35333 LATTICE CONSTANTS OF THORIUM SILICATE. **Sinha, Devendra Prasad; Prasad, Rameshwar (Patna Univ., India). Indian J. Phys.; 45: No. 2, 90-1(Feb 1971).**

$ThSiO_4$, prepared by hydrolysis of the chloride, was studied by x-ray diffraction. The lines were found to fit the body-centered tetragonal system. The lattice parameters were determined to be a = 7.148 Å, c = 6.309 Å, and c/a = 0.882. The density was 6.71 g/cm^3, and the number of molecules in the unit cell was 4. (D.L.C.)

35334 PRESSURE VARIABLE IN MATERIALS RESEARCH. **McWhan, D. B. (Bell Telephone Labs., Murray Hill, N. J.). Science; 176: No. 4036, 751-8(19 May 1972).**

A survey is presented of the effects of pressure on a few of the properties of elements: trends in periodic table, crystal structure, superconductors, magnetism in transition metals, and semimetal–semiconductor transitions in group V elements. The metal–insulator transition in vanadium oxide is also considered briefly. (69 references) (D.L.C.)

35335 MEASUREMENTS OF TIME DEPENDENT PERTURBED ANGULAR CORRELATIONS OF RARE EARTHS IMPLANTED IN COPPER. **Ryge, Peter. Madison, Wis.; Univ. of Wisconsin (1971). 75p. University Microfilms Order No. 71-23,326.**

Thesis.

Apparatus for performing such measurements as a function of time is described, and the technique is discussed. Attenuation mechanisms and theoretical results from the literature are reviewed. Results from data simulation studies are given. The time-differential correlations for Nd, Sm, Dy, and Er in Cu did not show the hard-core anisotropy predicted by the Blume model. A weak attenuation of less magnetic character was observed for Yb. For Gd, the anisotropy decayed rapidly to an almost constant value. (TSS) (Diss. Abstr. Int., B)

35336 LATTICE PARAMETERS OF Tm AND Lu BELOW ROOM TEMPERATURE. **Khanduri, Nawin C. Washington, D. C.;**

Howard Univ. (1970). 78p. University Microfilms Order No. 72-14,020.

Thesis.

Changes in the lattice parameters of thulium and lutetium with temperature in the range 90 to 300°K were investigated. X-ray-diffraction studies were made on powdered samples mounted inside a specially designed cryostat, with precise temperature control (within ±0.1°K) down to the temperature of the liquid nitrogen. The sample mount was made of solid copper to insure good thermal contact. Because of the higher precision, the backreflection lines were chosen, and a flat semifocusing camera was used. Because the sample was mounted inside the cryostat, the film-to-sample distance was treated as an unknown in addition to the hcp lattice parameters a and c. A least-square fit was used to obtain these unknowns; for convenience, the equations were linearized by a Taylor's expansion about the room-temperature values. Five diffraction lines were used for thulium and either four or eight lines were used for lutetium. The probable uncertainties in lattice parameters from the least-square fitting are approximately 0.002 Å. Within experimental errors, the lattice parameters a and c of thulium are linear functions of temperature. At 300°K, a = 3.535 ± 0.001 Å and c = 5.557 ± 0.002 Å. The average thermal expansion coefficient of the unit cell dimension c was 1.55×10^{-5}/°K. Contrary to the usual behavior, the lattice parameter a decreases slightly at higher temperatures. The average coefficient was -0.8×10^{-5}/°K. For lutetium, the room temperature lattice parameters were a = 3.517 ± 0.001 Å and c = 574 ± 0.002 Å. Similar to thulium, a small contraction in the lattice parameter a was observed as temperature increased, the average coefficient of expansion being -1.1×10^{-5}/°K. The behavior of the lattice parameter c was, however, quite nonlinear, and appeared to have a minimum value near 140°K. Above 140°K, the behavior of c was normal, the average thermal expansion coefficient being 1.6×10^{-5}/°K between 140 and 300°K. (TSS) (Diss. Abstr. Int., B)

35337 MAGNETIC-GROUND-STATE PROPERTIES IN PRASEODYMIUM SINGLE CRYSTALS. Andres, K. (Bell Telephone Labs., Murray Hill, N. J.); Bucher, E.; Maita, J. P.; Longinotti, L. D.; Flukiger, R. Phys. Rev., B; 6: No. 1, 313-17(1 Jul 1972).

From hyperfine-specific-heat measurements at very low temperatures, it is concluded that the ground state in double hcp Pr single crystals must be a magnetically ordered state. Within experimental error, the hyperfine specific heat in a single crystal is in agreement with data on polycrystalline material. This is surprising since recent neutron-scattering data in Pr single crystals do not indicate any magnetic order down to 1.7°K, while neutron-scattering data on polycrystalline samples indicated antiferromagnetic order with a Néel temperature of 25°K. (auth)

35338 ELECTRON PARAMAGNETIC RESONANCE OF DILUTE MAGNETIC ALLOYS: Mg:Er, Ag:Er, AND Au:Gd. Chui, Richard Hing-chak. Los Angeles; Univ. of California (1971). 160p. University Microfilms Order No. 72-13,595.

Thesis.

Dilute alloys of Mg: Er, Ag: Er, and Au: Gd were studied using EPR in order to investigate the exchange interaction with the conduction electrons in dilute magnetic alloys. The work of Burr and Orbach in dilute single crystals of Mg: Er was continued to lower Er concentrations (700 and 500 ppM). The g values were found to be nearly temperature-independent and the linewidth was observed to vary linearly with temperature, as $\Delta H = a + bT$. For the 700-ppM single crystal Mg: Er, b = 25 ± 2 gauss/°K and g = 9.20 ± 0.02 when the external magnetic field is parallel to the c crystal axis and b = 30 ± 2 gauss/°K and g = 5.80 ± 0.02 when the external magnetic field is perpendicular to the c crystal axis. The Kondo ln T g shift due to the second-order exchange interaction with the conduction electrons was suppressed. The coupling ρJ for Mg: Er is estimated to be −0.022 ± 0.002 where ρ is the conduction electron density of states at the Fermi surface and J is the localized-conduction electron exchange coupling constant. The anisotropic g value of Mg: Er can be described by the equation $g^2 = g_{\parallel}^2 \cos^2 \phi + g_{\perp}^2 \sin^2 \phi$ where ϕ is the angle between the external magnetic field and the c crystal axis of Mg. The work of Griffiths and Coles on Ag: Er was also continued to very low concentrations (86, 65, and 28 ppM) and low temperature (4.2 to 0.8°K). Again, the g value was found to be nearly temperature and concentration independent and the linewidth was observed to vary linearly with temperature, as $\Delta H = a + bT$. The residual linewidth, a, increased with the concentration of Er. The rate of change of temperature-dependent linewidth, b = 8 ± 1 gauss/°K for nearly all the different concentrations of Er studied. Because the exchange interaction was weak, the Kondo ln T g shift was too small to be detected. However, resolved hyperfine structure was observed for the first time in an alloy in samples of low concentrations of Er at 1.4°K and below. The hyperfine constant for ^{167}Er in Ag, A, was found to be 75 ± 1 gauss. Single crystals of Au: Gd with concentrations of Gd at 1000, 300, and 150 ppM were studied. A partially resolved fine structure was observed for the first time in an alloy when the external magnetic field was along the [100] direction at 1.4°K. The linewidth of all samples exhibit a strong angular dependence which would be explained by the unresolved fine structure of Gd in the cubic crystal field of Au. The crystal field parameter $b_4 = 20 \pm 1$ gauss. It is suggested that the RKKY interaction and the exchange interaction with the conduction electrons have merged the fine-structure lines and narrowed. Thus the line shape is distorted and the observed two-peak structure occurs only when the fine structure separation is at the maximum. It was found that the RKKY exchange field, $\Omega S(S + 1)$ was 31 ± 10 gauss where Ω is the hopping rate parameter for the RKKY exchange and S is the spin angular momentum of Gd and is equal to $^7/_2$. The g value obtained for Au: Gd is 2.05 ± 0.01, indicating a large positive g shift for an S state ion. (TSS) (Diss. Abstr. Int., B)

35339 PHOTOEMISSION INVESTIGATION OF THE ELECTRONIC STRUCTURE OF Re, W, Ta, Mo, AND Nb. Farrell, H. James. Notre Dame, Ind.; Univ. of Notre Dame (1972). 116p. University Microfilms Order No. 72-5124.

Thesis.

The energy distributions of photoelectrons from bulk polycrystalline samples of rhenium, tungsten, tantalum, molybdenum, and niobium were measured. A plane parallel geometry of emitter and collector was used, with a magnetic field to contain the obliquely emitted electrons. The samples were cleaned by electron bombardment in the vacuum chamber. Pressure was typically 10^{-7} torr. Photocurrent measurements were taken point-by-point, as the retarding voltage was changed in 0.25-V increments. Excitation energies were 21.2, 16.9, 11.6, 10.2, and 7.7 eV. The second derivatives with respect to voltage, of the normalized, retarded current were determined and used as a representation of the energy distribution of the excited electrons. The set of second-derivative curves for each sample was interpreted, using the approach developed by Spicer. Direct transitions from states below the Fermi level to those above the vacuum level were observed in Ta from states 3.75 eV below the Fermi level and in Nb from states about 4 eV below the Fermi level. No definitive evidence of nondirect transitions was observed. Structure was found in the density of states above the vacuum level. There are peaks in these states, located above the Fermi level at: 6.7 and 8.5 eV in W, 5.0 eV in Ta, 6.8 eV in Mo, and 5.2 eV in Nb. In Re, a peak was found in the density states 4.6 eV below the Fermi level. The positions of these peaks are in reasonable agreement with values predicted by Mattheiss' calculations for these metals. (Diss. Abstr. Int., B)

35340 PROCEEDINGS OF THE 1971 INTERNATIONAL CONFERENCE ON SOLID SURFACES, BOSTON, MASSACHUSETTS, OCTOBER 11–15, 1971. J. Vac. Sci. Technol.; 9: No. 2, 561-946(Mar-Apr 1972). (CONF-711005).

A total of 115 papers and abstracts are included, with an author index. Topics covered are chemisorption, electronic properties of adsorbed species, ion and electron scattering, catalysis, surface phonons and magnons, electronic properties of metallic interfaces, semiconductor interfaces, epitaxy and oxidation, scattering of atoms and molecules, photoeffects, physical adsorption, etc. Separate abstracts were prepared for 22 of the papers. Four papers have appeared previously in NSA; see NSA Vol 25, abstracts 55434, 55435, and 57237 and Vol 26, abstract 2196. (D.L.C.)

For abstracts of individual papers see: 33902, 33903, 33944–33953, 34405, 35256, 35341–35348.

35341 FIELD-EMISSION ENERGY DISTRIBUTIONS OF HYDROGEN AND DEUTERIUM ON THE (100) AND (110) PLANES OF TUNGSTEN. Plummer, E. W.; Bell, A. E. (National Bureau of Standards, Washington, D. C.). J. Vac. Sci. Technol.; 9: No. 2, 583-90(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Total energy distributions of field-emitted electrons from the tungsten (110) and (100) planes as a function of coverage by hydrogen and deuterium were recorded utilizing a spherical deflection energy analyzer. The elastic tunneling resonance spectrum gives a plot of the "local density of states" in the adsorbate. The inelastic tunneling spectrum reveals those discrete excitation energies available in the adsorbate–substrate complex. These spectroscopic data were used to infer the chemical nature of the binding states which have been observed in the flash desorption spectrum of hydrogen from tungsten. (auth)

35342 BAND STRUCTURE OF GRAPHITE STUDIED BY SECONDARY-ELECTRON EMISSION. Willis, R. F.; Fitton, B. (European Space Research and Tech. Center, Noordwijk, Netherlands). J. Vac. Sci. Technol.; 9: No. 2, 651-6(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Well-defined maxima were observed in the secondary electron emission spectrum of graphite excited by low-energy electrons, the energies of which show good agreement with emission from final states located at critical points in the conduction band of a recent band-structure calculation. Variation of the intensity of the maxima with angle of incidence of the primary beam, and the observation of interband transition thresholds, indicates that excitation occurs via direct transitions obeying optical selection rules. Transitions to higher excited states in the third Brillouin zone, of relevance to LEED intensity theories, were also observed. (auth)

35343 SURFACE DEBYE–WALLER FACTORS AND THERMAL EXPANSION COEFFICIENTS FOR Mo(100) AND Cr(100). Tabor, D.; Wilson, J. M. (Cambridge Univ., Eng.). J. Vac. Sci. Technol.; 9: No. 2, 695-8(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

LEED was used to measure Debye–Waller factors for Mo(100) and Cr(100) surfaces near normal incidence. The derived effective Debye temperature as a function of electron beam energy shows fluctuations which are 18 to 25% higher on peaks near the Bragg voltage than on those measured near half-order Bragg voltages. The results suggest that the origin of these fluctuations is multiple diffraction. The thermal expansion coefficient was also estimated. Measurements of energy shifts of the (00) intensity peaks with temperature give values between two and three times the average bulk value over the same temperature range. These results are consistent with large vibrational amplitudes when discussed in terms of the Grueneisen relation and a simple interatomic potential. (auth)

35344 PLASMON ANGULAR PROFILES IN LOW ENERGY ELECTRON DIFFRACTION FROM SINGLE CRYSTALS. Stein, R. J.; Stern, R. M. (Polytechnic Inst. of Brooklyn). J. Vac. Sci. Technol.; 9: No. 2, 743-6(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Measurement of surface and bulk plasma peaks in the secondary electron distribution from Ni(100) and W(110) provides confirmation of two-step inelastic diffraction. Angular profiles are made in the neighborhood of selected prominent elastic diffraction maxima. Momentum conservation parallel to the surface leads to the prediction of a doublet structure in the angular distribution of diffracted electrons having lost the surface plasmon energy. This structure is observed. The observed structure in the bulk plasmon loss angular profile is more complex and is indicative of other conservation laws. (auth)

35345 CHEMICAL SHIFTS IN THE AUGER SPECTRUM OF YTTRIUM ON OXYGEN ADSORPTION. Baker, J. M. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Vac. Sci. Technol.; 9: No. 2, 792-6(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Adsorption of monolayer amounts of oxygen on yttrium films and molybdenum foil was studied with Auger electron spectroscopy. Exposure of yttrium to 0.3 to 15×10^{-6} torr-sec of oxygen resulted in the growth of new Auger peaks shifted by about −4 eV from the yttrium metal peaks involving the 4p, 4d, and valence levels. For molybdenum, these levels were unaffected by oxygen adsorption. A background correction technique was applied in order to remove the effects of secondary electron emission from the data. The growth of the shifted peaks is followed in the spectra and the results are discussed in terms of the electronic structure of the metal and its oxide. (auth)

35346 SCATTERING OF ATOMS AND MOLECULES FROM TUNGSTEN: EFFECT OF SURFACE COMPOSITION AND CRYSTAL ORIENTATION. Stickney, R. E.; Tendulkar, D. V.; Yamamoto, S. (Massachusetts Inst. of Tech., Cambridge). J. Vac. Sci. Technol.; 9: No. 2, 819-24(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Molecular-beam techniques were used to study the scattering of various gases (He, Ar, N_2, CO, and D_2) from W (112) and W (110) crystals. The crystal temperature is varied from 300 to 2400°K, and the partial pressure of oxygen is varied from an undetectable level to 1×10^{-7} torr to alter the amount (coverage) of oxygen adsorbed on the surface. The results illustrate the strong dependence of the scattering process on surface composition and crystal orientation. The dependence is particularly strong in the case of He, where diffraction is observed at one extreme and essentially diffuse scattering is observed at the other extreme. The results for CO and N_2 appear to be consistent with existing data on their sticking probabilities for W (112) and W (110). (auth)

35347 CHANGES IN PHOTOELECTRON EMISSION FROM MOLYBDENUM DUE TO EXPOSURE TO GASES. Clewley, J. D.; Crowell, A. D.; Juenker, D. W. (Univ. of Vermont, Burlington). J. Vac. Sci. Technol.; 9: No. 2, 877-81(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Observations of photoelectron emission from metal surfaces have been used by many investigators to study changes in work function due to exposure to gases. Although changes in the photoemission characteristics not attributable to work function changes have also been observed, there seems to have been little attempt to interpret these changes in terms of electronic changes at the surface. Studies of the changes produced in the surface photoelectric yield of polycrystalline Mo due to exposure to CO, N_2, and O_2 were made using vectorial photoeffect methods and interpreted with the aid of a simple Sommerfeld model due to Mitchell which introduces an effective depth of the Fermi sea. Changes in this depth as well as work function changes were inferred. Exposure to gases increases the work function but decreases the effective depth of the Fermi sea. (auth)

35348 FIELD-EMISSION STUDY OF SILICON ON TUNGSTEN. Swenson, O. F.; Sinha, M. K. (North Dakota State Univ., Fargo). J. Vac. Sci. Technol.; 9: No. 2, 942-6(Mar-Apr 1972).

From International conference on solid surfaces; Boston, Mass. (11 Oct 1971).

Small amounts of silicon evaporated onto a clean tungsten tip in ultrahigh vacuum show two distinct types of surface diffusion. At about 550°K, boundary-free diffusion occurs on the [111] zones. Above 950°K, diffusion occurs with a sharp boundary and an activation energy of 1.5 eV. The activation energy of thermal desorption of silicon from tungsten depends on the surface coverage and varies from 5.6 to 6.2 eV. Annealing the silicon-covered tip at ≈1400°K causes diffusion of silicon into the interior of tungsten and produces a different and stable pattern, probably that of a tungsten silicide with a work function of 4.8 eV. (auth)

35349 TOWARD SIMPLE POWERS OF T IN THE KONDO EFFECT. II. SOME REMARKS ON GOLD–VANADIUM. Star, W. M. (State Univ., Leiden). Physica; 58: No. 4, 623-30 (15 Apr 1972).

Experimental data on the low-temperature specific heat and electrical resistivity of some dilute Au–V alloys are discussed. It is shown that, most probably, the specific heat of noninteracting V atoms varies as T and the resistivity as T^2. Initially, interactions tend to lower the effective Kondo temperature. (auth)

35350 ANOMALOUS TEMPERATURE DEPENDENCE OF ELASTIC CONSTANTS IN Nb–Mo ALLOYS. Hubbell, W. C.; Hayes, D. J.; Brotzen, F. R. (Rice Univ., Houston, Tex.). Phys. Lett.; 39A: No. 4, 261-2(22 May 1972).

An unusual positive temperature coefficient of c_{44} was observed in the Nb-rich Mo alloys, which appears to be connected with previously reported anomalies in neutron-diffraction and specific-heat data. (auth)

35351 ELASTIC CONSTANTS OF DYSPROSIUM AND HOLMIUM. Palmer, S. B. (Univ of Hull, Eng.); Lee, E. W. Proc. Roy. Soc. (London), Ser. A; 327: No. 1571, 519-43 (25 Apr 1972).

The five single-crystal elastic constants of dysprosium and holmium were measured within the temperature range 4.2 to 300°K. The large contributions to the elastic constants due to domain and spin-rotation effects were eliminated by applying a magnetic field of 2.5 T along the magnetic easy directions. Extrapolation of the temperature dependence in the paramagnetic region to 0°K indicates large magnetic contributions to the elastic constants which were interpreted as arising from the strain dependence of the exchange energy. Analysis of these contributions permits the evaluation of the first and second derivatives of the nearest and next-nearest exchange interaction parameters. The results are consistent with more limited information obtainable from the anomalous thermal expansion and are consistent with an oscillatory J(r). (auth)

35352 NEUTRON BACKSCATTERING AT HIGH DOPPLER VELOCITIES FOR MEASURING DIFFERENCES IN LATTICE PARAMETERS. Bauer, G. (Institut fuer Festkoerperforschung, Juelich, Ger.). Kerntechnik; 14: No. 2, 82-5(Feb 1972). (In German and English).

The method of Doppler shift in neutron backscattering from crystals in nonuniform motion is used to measure differences in lattice parameters. A crystal drive for high Doppler velocities is described, which makes it possible to achieve a good time efficiency by the use of eight similar analyzer crystals, thus limiting the range of crystal velocity variation to the region of interest which is of the order of a few linewidths. The facility allows simultaneous detection of the neutrons transmitted and of those reflected by the sample. The electronic equipment is described briefly. (auth)

35353 INTERATOMIC INTERACTION IN SOLID REFRACTORY COMPOUNDS OF TITANIUM, VANADIUM, AND CHROMIUM WITH NONMETALS. **Zhurakovskii, E. A.; Dzeganovskii, V. P.; Bondarenko, T. N. (Inst. of Problems in Material Management, Kiev). Metallofizika; No. 37, 37-41(1971). (In Russian).**

New data are given for the $K\beta_5$ vanadium and titanium bands for some nitrides, carbides, and the diboride of V and Ti, and for $VL\alpha_{1,2}$ and $NK\alpha$ bands of V_3N and VN. The L spectra in chromium borides, carbides, and nitrides are discussed. (tr-auth)

35354 MAGNETISM OF RARE-EARTH ELEMENTS, ALLOYS, AND COMPOUNDS. Rhyne, James J. (Naval Ordnance Lab., Silver Spring, Md.); McGuire, Thomas R. IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet.; MAG-8: No. 1, 105-30(Mar 1972).

The magnetic properties of the rare-earth metals and a number of the alloy and compound systems formed with rare earths are discussed. Emphasis is placed on current experimental results of bulk magnetic measurements and related transport phenomena and their bearing on theoretical studies. Topics covered include exchange interactions, magnetization processes, crystal-field effects and anisotropy, magnetostriction, spin structures and their field dependence, specific heat, optical effects, resistivity, magnetoresistivity, and other transport properties affected by the magnetic order. Examples are drawn from a number of material systems including ionic compounds, solid-solution compounds (e.g., rare-earth magnetic semiconductors), intermetallic compounds (permanent magnet materials, etc.), and bubble domain materials in addition to the rare-earth elements and intra-rare-earth alloys. Twenty figures and 9 tables are presented giving the spin structures, ordering temperatures, saturation and effective moments, and other properties of the elements and specific compounds. 206 references. (auth)

35355 CESIUM ADSORPTION ON W: ELLIPSOMETRY, AUGER SPECTROSCOPY, AND SURFACE POTENTIAL DIFFERENCE STUDIES. Smith, Tennyson (North American Rockwell Science Center, Thousand Oaks, Calif.). J. Appl. Phys.; 43: No. 7, 2964-70(Jul 1972).

A study was made of cesium adsorption on W and Ti using the combined measurements of ellipsometry, Auger spectroscopy, and surface potential difference measurements. The single and polycrystals of W were cleaned in ultrahigh vacuum ($\sim 2 \times 10^{-10}$ torr) and the cesium deposited as an ion beam at low voltages (5 to 30 V). The deposition of Cs^+ did not occur unless some oxygen was detected on the sample by Auger spectroscopy. The sticking coefficient for Cs/W proved to be directly proportional to the concentration of oxygen on the W in the range 0 to 0.1 fraction of a monolayer oxygen coverage. The optical constants of bulk Cs can be used to interpret ellipsometric results for the adsorption of Cs on W and Ti in the region above, at and below monolayer coverage. The coverage obtained for the work-function minimum is consistent with earlier work by Taylor and Langmuir. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 33176, 33474, 35237, and 35250.

35356 INTERPRETATION OF MOESSBAUER FRACTIONS OF ^{83}Kr 9.3 keV TRANSITION BY INELASTIC NEUTRON SCATTERING. Gupta, N. P. (Univ. of Jodhpur, India). Lett. Nuovo Cim.; 3: No. 14, 599-600(1 Apr 1972).

Inelastic neutron scattering was used to measure the phonon dispersion relation for the symmetric [100], [110], and [111] directions by using a single crystal of Kr. This phonon spectrum was used to compute the recoils fraction for the 9.3-keV transition. The results obtained lie just above the experimental errors of published measurements. (1 figure) (R.W.R.)

35357 QUADRUPOLE SPLITTING OF THE 6.2-keV γ RAYS OF ^{181}Ta IN RHENIUM METAL. Kaindl, G. (Univ. of California, Berkeley); Salomon, D.; Wortmann, G. Phys. Rev. Lett.; 28: No. 15, 952-5(10 Apr 1972).

Recoilless nuclear resonance absorption of the 6.2-keV γ rays of ^{181}Ta was used to study the hyperfine interaction of ^{181}Ta in Re metal. From the completely resolved Mössbauer spectra measured at room temperature parallel and perpendicular to the [0001] axis of the single-crystalline ^{181}W(Re) sources, the sign and magnitude of the nuclear quadrupole interaction, $e^2qQ(^7/_2) = -(2.15 \pm 0.02) \times 10^{-6}$ eV, the quadrupole-moment ratio $Q(^9/_2)/Q(^7/_2) = 1.133 \pm 0.010$, and the isomer shift of ^{181}Ta(Re) relative to Ta metal, −14.00 ± 0.10 mm/s were derived. (auth)

35358 MOESSBAUER EFFECT METHODOLOGY. VOLUME 7. Proceedings of the Seventh Symposium, New York City, January 31, 1971. Gruverman, Irwin J. (ed.). New York; Plenum Publishing Corporation (1971). 318p. $21.50. (CONF-710119).

Fifteen papers are presented on developments in the techniques and applications of Moessbauer spectroscopy. Local moment measurement; radiation damage studies; Moessbauer parameters in iron, tin, and europium; conversion-electron spectroscopy; a source for ^{119}Sn−^{121}Sb; a "blackness" distortion removal technique; and use of radio frequency fields were among the topics. A separate abstract was prepared for each of six of the papers. (D.L.C.)

For abstracts of individual papers see: 35237, 35359–35362, and 35371.

35359 ANALYTICAL DETERMINATION OF MAGNETIC AND QUADRUPOLE HYPERFINE PARAMETERS FROM MOESSBAUER SPECTRA. Williams, P. G. L.; Bancroft, G. M. (Univ. of Western Ontario, London). Moessbauer Eff. Methodol., Proc. Symp.; 7: 39-58(1971).

From seventh symposium on Moessbauer effect methodology; New York, N. Y. (31 Jan 1971).

A general analytical method is outlined for determining the magnetic and quadrupole hyperfine parameters directly from an observed Moessbauer spectrum for most of the common nuclear spins. The Hamiltonian matrix describing the interaction of the field system with the nucleus is set up for nuclear spins up to $I = ^9/_2$. From the above matrix, a secular determinant is constructed that is expanded to give the secular polynomial, whose 2I + 1 roots are the energy eigenvalues of the nucleus. These eigenvalues may be determined easily from many observed spectra. By equating the sums of the products of these roots to the coefficients of the powers of E in the secular polynomial, equations are obtained that are solved to give the hyperfine parameters. To illustrate the usefulness of the above method, hyperfine parameters were obtained for iodine-129 and neptunium-237 Moessbauer spectra reported in the literature. The significant advantages and possible difficulties in the method are critically examined. (auth)

35360 MOESSBAUER EFFECT OF ^{57}Fe IN RARE GAS MATRICES AT 4.2K. McNab, T. K.; Barrett, P. H. (Univ. of California, Santa Barbara). Moessbauer Eff. Methodol., Proc. Symp.; 7: 59-83(1971).

From seventh symposium on Moessbauer effect methodology; New York, N. Y. (31 Jan 1971).

A matrix-isolation apparatus and experimental procedures for Moessbauer nuclei evaporated from a furnace are described. Results are reported for ≤3 at. % of Fe metal in solid Ar, Kr, and Xe matrices at 4.2°K. Monomer isomer shifts, monomer linewidths, and dimer quadrupole splittings are discussed, and dimer/monomer ratios were computed for the Ar and Kr spectra. Impurity lines and distortion effects are considered, and possible applications of the rare-gas matrix isolation technique are described. (17 references) (D.L.C.)

35361 CONVERSION-ELECTRON MOESSBAUER SPECTROSCOPY. Spijkerman, Jon J. (Scientific Research Corp., Alva, Okla.). Moessbauer Eff. Methodol., Proc. Symp.; 7: 85-96 (1971).

From seventh symposium on Moessbauer effect methodology; New York, N. Y. (31 Jan 1971).

Although most ^{57}Fe Moessbauer spectra are obtained with transmission geometry, several reflection (backscattering) techniques have been recently published. The scattering technique eliminates the need of sample preparation and provides a method for nondestructive testing of surfaces. The initial scattering experiments made use of the re-emitted 14.4-keV gamma radiation. However, due to the internal conversion process, this method is only 10% efficient, and the radiation is converted into 6.3-keV x rays and conversion electrons. The atomic absorption of the γ and x radiation limits the penetration depth to 0.0005 inches. The 7.3- and 5.5-keV conversion electrons have a very limited range, less than 3000 Å in iron. The detection of x rays thus primarily provides a bulk sample analysis, while the conversion electrons provide information on thin surface films (50 to 3000 Å), with applications in surface corrosion, surface absorption, catalysis, surface stresses, etc. The backscattering technique requires the design of special detectors, shielding, and source-sample-detector geometry. The design of these detectors is described, and the merits of the various detection techniques compared. Applications of the conversion electron detector are discussed. (18 references) (auth)

35362 PROPERTIES OF $Ni_{21}Sn_2B_6$ AS SOURCE FOR ^{119}Sn AND ^{121}Sb MOESSBAUER EXPERIMENTS. Bowen, L. H.; Taylor, K. A.; Dokuzoguz, H. Z.; Stadelmaier, H. H. (North Carolina State Univ., Raleigh). Moessbauer Eff. Methodol., Proc. Symp.; 7: 233-44(1971).

From seventh symposium on Moessbauer effect methodology; New York, N. Y. (31 Jan 1971).

A study was made of Moessbauer sources of $Ni_{21}\ ^{121}Sn_2B_6$ and $Ni_{21}\ ^{119m}Sn_2B_6$ at ~80°K. Spectra, recoilless fractions, and isomer shifts were measured. The results show that this alloy is comparable to other sources and should be considered as a possible standard as it is quite stable. No change was observed in spectral quality over a year, and immersion in water and evaporation to dryness did not change the linewidth. (D.L.C.)

35363 MOESSBAUER RECOIL-FREE FRACTION AND DEBYE–WALLER FACTORS FOR Nb_3Sn. Hewat, A. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Phys. Lett.; 39A: No. 3, 249-50(8 May 1972).

The very low values and anomalous temperature dependence obtained for the Moessbauer recoil-free fraction of ^{119}Sn in Nb_3Sn cannot be explained by the unusual elastic properties of this crystal. Calculations based on the elastic constants support the recent x-ray B factors. The recoil-free fractions would have to be doubled to obtain agreement with these results, in which case the anomaly in the temperature dependence would also disappear. (auth)

35364 ANALYSIS OF BACKSCATTER MOESSBAUER SPECTRA OBTAINED WITH INTERNAL CONVERSION ELECTRONS. Krakowski, R. A.; Miller, R. B. (Ohio State Univ., Columbus). Nucl. Instrum. Methods; 100: No. 1, 93-105(1972).

The dependence of resonance line width, resonance area, and magnitude of the Moessbauer effect on film thickness is analytically resolved for Moessbauer backscattering spectra obtained via the conversion electron. An exponential attenuation law and Fermi-age/diffusion theory are used and intercompared. The Fermi-age/diffusion theory permits the calculation of the conversion electron energy spectrum. The calculated electron energy spectrum for ^{119}Sn is compared to experiment, and the feasibility of obtaining spatially resolved Moessbauer spectra from thin films is discussed. (auth)

35365 NMR STUDY OF $ThAl_2$: ^{27}Al, DIPOLAR DOUBLET, QUADRUPOLE, AND ANISOTROPIC SHIFT INTERACTIONS. Torgeson, D. R.; Barnes, R. G.; Creel, R. B. (Ames Lab., Iowa, Iowa State Univ., Ames). J. Chem. Phys.; 56: No. 8, 4178-83 (15 Apr 1972).

The nuclear magnetic resonance spectra of powdered intermetallic compounds MX_2 of the C32 (AlB_2) structure type lend themselves to analysis and interpretation in terms of nuclear dipole doublet interaction, nuclear electric quadrupole, and anisotropic Knight-shift interactions. Within the hexagonal plane of the C32 structure three Pake pairs may be formed with each of the X nearest neighbors. The observed doublets in the NMR spectra of X nuclei are of the Pake type when the magnetic moment of the N nuclear species is small. Examples are ^{11}B in ZrB_2 and TiB_2 and ^{27}Al in $ThAl_2$. An extensive analysis of the $ThAl_2$ NMR spectra is presented that yields values for the lowest pure quadrupole frequency $\nu_Q = 230.5 \pm 2.0$ kHz and Knight shift parameters $K_{iso} = (0.042 \pm 0.003)\%$ and $K_{ax} = -(0.012 \pm 0.003)\%$. The nearest-neighbor distance obtained was in agreement with spacings determined by x-ray techniques. (auth)

35366 REAL SHAPE OF SPECTRAL LINES IN MOESSBAUER SPECTROSCOPY. Delyagin, N. N.; Mitrofanov, K. P.; Nesterov, V. I. (Moscow State Univ.). Nucl. Instrum. Methods; 100: No. 2, 315-16(1972).

The effect of experimental geometry on the line shape in Moessbauer spectroscopy is considered. The real spectral line is shown to be asymmetric, and the asymmetry of the lines is rapidly increased with increasing of the velocity of the source. (auth)

35367 ZERO-FIELD SPLITTINGS OF Cm^{3+} AND Am^{2+} IN FLUORITE TYPE CRYSTALS. Kolbe, W. (Univ. of California, Berkeley); Edelstein, N.; Finch, C. B.; Abraham, M. M. J. Chem. Phys.; 56: No. 11, 5432-3(1 Jun 1972).

The $\Gamma_6 - \Gamma_8$ energy level splittings were derived for Cm^{3+} and Am^{2+} in several fluorite-type crystals from measurements of the anisotropy of the g value of the Γ_6 state at 35 GHz. Anisotropy measurements were also made of the g value of the excited Γ_7 state for Cm^{3+} in $SrCl_2$, and the $\Gamma_8 - \Gamma_7$ splitting was obtained. (auth)

35368 ELECTRON PARAMAGNETIC RESONANCE OF Nd^{3+} IONS IN LANTHANUM HYDRIDE MATRICES. Stalinski, B.; Drulis, H. (Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 19: No. 11-12, 739-42(1971).

The EPR spectra of Nd^{3+} ions in lanthanum hydride matrices, $LaH_{2+\delta}$ $(0 < \delta < 1)$, were investigated at 9.3 kMHz. The estimated g-factors $(g \cong 2.08)$ were interpreted in terms of the transitions within $\Gamma_8^{(2)}$ quartet as the lowest level, thus favoring the anionic model of lanthanum hydride. (auth)

35369 MOESSBAUER ISOMER SHIFTS IN ^{149}Sm COMPOUNDS. Eibschuetz, M.; Cohen, R. L.; Buehler, E.; Wernick, J. H. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 6: No. 1, 18-23(1 Jul 1972).

The isomer shift (IS) of the 22.5-keV γ transition of ^{149}Sm was studied for various ionic, semiconducting, and metallic compounds using Moessbauer spectroscopy. Changes were found as large as 0.9 mm/sec between trivalent and divalent compounds and 0.3 mm/sec between metallic and ionic trivalent compounds. The divalent compounds show a range of IS due to covalency effects, and the intermetallic compounds, which all have Sm in the trivalent state, show the extra electronic density due to the conduction electrons. The IS obtained for the semiconducting SmB_6, −0.4 mm/sec, and for the chalcogenide Sm_3S_4, −0.19 mm/sec, are anomalous. The difference in the mean-square charge radius between the 22.5-keV state and the ground state was calculated as $\delta\langle r^2\rangle = 1.2 \times 10^{-3}$ fm^2. The conduction-electron density at the nucleus of Sm metal $|\Psi|^2\ (CE) = 0.95 \times 10^{26}\ cm^{-3}$. The solid-state and nuclear results are discussed in the light of current theories. (auth)

35370 ELECTRON-SPIN-RESONANCE ABSORPTION SPECTRUM OF MONOVALENT IRON IN SINGLE-CRYSTAL THORIUM OXIDE. Marshall, S. A.; Nistor, S. V. (Argonne National Lab., Ill.). Phys. Rev., B; 6: No. 1, 24-34(1 Jul 1972).

The magnetic-resonance absorption spectrum of an $S = \frac{3}{2}$ system having tetragonal symmetry was observed in single crystals of thorium oxide. The spectrum is readily observed at temperatures of 100°K and below, while above this temperature region the spectral components lose their peak intensities due to what is believed to be lifetime broadening induced by spin–lattice interaction. For Zeeman fields of up to 16,000 Oe using either 0.32- or 1.2-cm^{-1} radiation, the overall spectrum consists of three components, each of which is interpreted as being associated with a site of tetragonal symmetry whose principal axis is directed along one of the three cube edges. At 77°K, the fine-structure spectral parameters are estimated to be $g_{||} = 2.0117$, $g_\perp = 2.0630$, and $D = 2.95$ cm^{-1} while the hyperfine structure parameters associated with ^{57}Fe are $A_{||} = 11.9$ Oe and $A_\perp = 8.8$ Oe. It is suggested that the paramagnetic ion responsible for this spectrum is monovalent iron located at distorted eightfold-coordinated metal-ion sites of thorium oxide. Spin–lattice relaxation-time data obtained from 1.25 to 45°K and from 100 to 200°K are reported and discussed with respect to spectroscopic data. (auth)

Theory

35371 RELATIVISTIC EFFECTS IN HYPERFINE INTERACTIONS. Dunlap, B. D. (Argonne National Lab., Ill.). Moessbauer Eff. Methodol., Proc. Symp.; 7: 123-45(1971).

From seventh symposium on Moessbauer effect methodology; New York, N. Y. (31 Jan 1971).

The treatment of the theory of hyperfine interactions, beginning initially from a relativistic viewpoint, yields a number of results that differ from those of the nonrelativistic approach. For both dipole and quadrupole interactions, one finds the necessity for different $\langle r^{-3}\rangle$ values for each in the terms of the Hamiltonian. In the magnetic dipole case, an additional term is present which has the appearance of a core polarization contribution to the hyperfine field, although it arises strictly from the open-shell electrons. In the electric quadrupole case, two additional interactions appear which have no nonrelativistic analogue. The relativistic approach is briefly summarized and applications to the lanthanide and actinide series reviewed. Of particular interest is the consideration of experimental values of $\langle r^{-3}\rangle$ and of core polarization fields. (5 tables, 38 references) (auth)

35372 CONCERNING THE ROTATION OF THE PLANE OF LINEAR POLARIZATION OF γ QUANTA IN A MAGNETIZED FERROMAGNET. Baryshevskii, V. G.; Dumbrais, O. V.; Lyuboshitz, V. L. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.); 15: No. 2, 78-80 (20 Jan 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 15: No. 2, 113-16(20 Jan 1972).

The theoretical angle of rotation of the plane of linear polarization of a photon over a length x is $\phi = -Nr_0^2\psi(\kappa)(p\vec{l})x$. Values of the function $\psi(\kappa)$ for κ from 0.1 to 4 (E_γ from 50 to 2000 keV) are tabulated; they show a broad maximum in the region 500 to 700 keV (max $\psi = \psi(1.18) = 0.3953$). The negative values of $\psi(\kappa)$ agree with experiment. For magnetized iron, $\phi_0 = -13.48 \times 10^{-3}\psi(\kappa)$ rad/cm, and $\phi = 4.12 \times 10^{-3}$, 4.61×10^{-3}, and 4.83×10^{-3} rad/cm for the energies 230, 290, and 330 keV, respectively. This agrees with the experimental results of Lobashov et al. (JETP Lett. 14: 251 (1971)) and with the 330-keV result of Bock and Luksch (Lett. Nuovo Cim. 2: 1081(1972)), but not with their 230-keV result. (D.L.C.)

PHYSICS (THEORETICAL)

Refer also to abstracts 34160, 34594, 34752, and 35374.

35373 SOLVABLE POTENTIALS FROM SHARPE'S, HERMITE, AND LAGUERRE EQUATIONS. Sharma, L. K.; Singh, F. (Government Engineering Coll., Rewa, India). Indian J. Phys.; 45: No. 1, 1-8(Jan 1971).

A few solvable potentials for the Schrödinger equation were constructed by using second order Sharpe's, Hermite and Laguerre differential equations following the method of Bhattacharjie and Sudarshan (1962). Similar potentials were shown to be obtained by the method formulated by Bose (1963). The solution and s-matrix of one of the potentials derived from Sharpe's differential equation and the possibility that this potential may find application in diatomic molecules were also discussed. (auth)

35374 INEQUALITIES FOR QUANTUM-STATISTICAL RESPONSE FUNCTIONS. Okubo, S. (Univ. of Rochester, N. Y.); Isihara, A. Physica; 57: No. 3, 421-31(1 Feb 1972).

Important general inequalities are derived for the derivatives of the partition function of a quantum system with respect to the parameters included in the Hamiltonian. Applications of the inequalities are used to discuss relations for critical initial exponents, kinetic energy, susceptibility, electrical conductivity and so on. Existence of an inconsistency analogous to the Schwinger-term difficulty in the quantum field theory is pointed out. (auth)

35375 PERTURBATIONS AND NON-NORMALIZABLE EIGENVECTORS. Faris, William G. (Battelle Inst., Geneva). Helv. Phys. Acta; 44: No. 7, 930-6(31 Dec 1971).

A spectral representation of a self-adjoint operator acting in a Hilbert space is given by eigenvectors of an extension of the operator to a suitable space containing the original Hilbert space. A perturbation argument shows the extended operator has no eigenvalues that do not belong to the spectrum of the original operator. The abstract result is applied to Schrödinger operators $-\Delta + V$. (auth)

35376 BOGOLYUBOV THEORY OF BOSE CONDENSATION AS A MEAN FIELD THEORY. Wiegel, F. W. (Univ., Amsterdam); Jalickee, J. B. Physica; 57: No. 3, 317-33(1 Feb 1972).

A c-number formalism for the interacting Bose gas is developed The grand canonical partition function is represented by a simple functional integral. It is shown from first principles that the stable and metastable states of the system obey an equation which has the form of a slightly generalized Landau–Ginzburg equation. The energies of the quasiparticles are directly related to the curvatures of the functional surface. The quadratic approximation to the functional integral turns out to be equivalent to the finite temperature extension of the Bogoliubov theory of the Bose fluid. The analogy between the condensation of a classical gas, and the condensation phenomenon in the Bose gas is elucidated. The relation of this wor with some work of Rice and Langer is discussed briefly. (auth)

35377 ERROR ANALYSIS OF THE ALGEBRAIC METHOD FOR SOLVING THE SCHROEDINGER EQUATION. Ixaru, L. Gr. (Inst. of Atomic Physics, Bucharest). J. Comput. Phys.; 9: No. 1, 159-63(Feb 1972).

A detailed analysis of the error analysis of the algebraic method for solving the Schroedinger equation is made. It is found that the algebraic method is a second-order method. (J.F.P.)

35378 DIVERSE STRATEGY METHOD OF MINIMIZATION. Baker, George A. Jr.; Hunter, D. L. (Brookhaven National Lab., Upton, N. Y.). J. Comput. Phys.; 9: No. 2, 273-89(Apr 1972).

The problem of finding the minimum of a function down according to the type of surface encountered locally is solved. Based on this surface classification the viewpoint is adopted that minimization strategy ought to be most effective. A modified version is given of Krylov's eigenvector method, with a starting vector derived by a theorem of Lagrange and Beltrami. A convenient lower bound on the condition number of a positive definite matrix is obtained. A number of numerical examples of the procedure are given. The methods presented depend on the availability of analytic expressions for the first and second derivatives. (auth)

35379 CANONICAL TRANSFORMATIONS AND QUADRATIC HAMILTONIANS. Currie, D. G. (Univ. of Maryland, College Park); Saletan, E. J. Nuovo Cim.; 9B: No. 1, 143-53(11 May 1972).

It is shown that there exist symmetry transformations in phase space that preserve Hamilton's canonical equations of motion for one Hamiltonian, but not for all. Examples of these "canonoid" transformations are given and their relation to canonical transformations is developed. It is demonstrated that a sufficient condition for a canonoid transformation to be canonical is that it preserves Hamilton's equations for all Hamiltonians quadratic in the q's and p's. (auth)

35380 EVALUATION OF ANGULAR MOMENTUM COUPLING COEFFICIENTS. Wills, J. G. (Indiana Univ., Bloomington). Comput. Phys. Commun.; 2: No. 6, 381-2(Oct-Nov 1971).

A change in a recent program for the evaluation of angular momentum coupling coefficients is suggested which will result in a faster, more accurate code. The change is illustrated for the Clebsch–Gordan coefficients. A similar modification for the Racah coefficients is easily obtained. (J.W.R.)

35381 MODIFICATION OF THE VARIABLE PHASE METHOD FOR OPTIMUM NUMERICAL CALCULATION OF PHASE SHIFTS. Kaup, David J. (Clarkson Coll. of Tech., Potsdam, N. Y.). J. Comput. Phys.; 9: No. 2, 254-72(Apr 1972).

A modification of the variable phase method was found which can significantly decrease computational time and, at the same time, give stable solutions except in energy regions close to resonances. In particular, by redefining the phase of the variable phase method, one can obtain a first-order, nonlinear differential equation for the redefined phase. Since the solution of this equation is relatively slowly varying, rapid numerical integration is possible. The similarity of this redefined phase to the JWKB phase is pointed out, and this modified variable phase method is compared with other well-known methods of numerically calculating phase shifts. (auth)

35382 MAPPING OF SPIN MATRICES ON POLYNOMIALS. Kaplan, D. M. (Virginia Polytechnic Inst. and State Univ., Blacksburg). Transp. Theory Statist. Phys.; 1: No. 2, 81-100 (1971).

A mapping between spin matrices and polynomial functions is exhibited. Matrix multiplication is replaced by specific left-right differential operators. The procedure supplies the natural extension of the method of Wigner distributions to include spin. (auth)

35383 REMARKS ON THE CONSTRUCTION OF THE NON-RELATIVISTIC COULOMB GREEN'S FUNCTION. Chen, Augustine C. (St. John's Univ., Jamaica, N. Y.); Chen, Joseph C. Y.; Rajagopal, A;. K. Phys. Rev., A; 5: No. 6, 2686-7(Jun 1972).

The equivalence of the expressions for the Coulomb Green function derived by Schwinger and by Okubo and Feldman is shown. (J.F.P.)

35384 REFORMULATING QUANTUM MECHANICS AND STOCHASTIC THEORY. Ogunlana, J. (Univ. of California, Berkeley). J. Statist. Phys.; 4: No. 2-3, 217-25(Mar-Apr 1972).

A stochastic theory approach is used to formulate the theory of quantum mechanical motion. Apart from giving a unifying point of view to quantum mechanics and stochastic theory, the new formulation is not limited to forces derivable from a potential. A nonlinear dynamical law is deduced in contradistinction to previous works in which ad hoc linear laws are postulated. (auth)

35385 DISTRIBUTION OF EIGENVALUES FOR A CLASS OF REAL SYMMETRIC MATRICES. Dyson, Freeman J. (Inst. for Advanced Study, Princeton, N. J.). Rev. Mex. Fis.; 20: No. 4, 231-7(1971).

An ensemble of real symmetric matrices H is defined by $H = \mathrm{Re}(M^+M)$, where M is an asymmetric complex matrix whose elements are independent Gaussian random variables. Using the theory of Brownian motion, the probability-distribution of the eigenvalues of H is determined exactly. When the order of the matrices tends to infinity, the density of eigenvalues in the neighborhood of E trends to $x^{-1}(6x - 1 - x^2)^{1/2}$, where $x = \frac{1}{2}(E/E)$ and E is the mean of the eigenvalues. The density is zero in the interval $0 < E < (3/2 - \sqrt{2})\ E$. (auth)

REACTOR TECHNOLOGY

Power Reactor Development

Refer also to abstracts 33923, 35588, 35589, and 35594 –35596.

35386 POWER PLANTS USING ORDINARY WATER TYPE REACTORS. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 91, 5-11(Sep 1971). (In French).

The basic characteristics of light water reactors are briefly reviewed: cooling safety aspects, operation, exploitation, and control. Two types of light water reactors are compared: pressurized water reactors (PWR) and boiling water reactors (BWR). (France)

35387 NUCLEAR POWER PLANTS IN ELECTRICITY SUPPLY. Boernke, F. (Rheinisch-Westfaelisches Elektizitaetswerk AG, Essen). Konstr. Ing. Ber.; No. 10, 6-16(1971). (In German).

Estimates are given up to the year 2000 for the power requirement of the world, the development of primary energy sources for gross electricity generation and the development of the electricity generation as related to the total energy requirement of the FRG. The share occupied by nuclear energy in the FRG and its increase and importance are considered in particular. A comparison of conventional and nuclear power plants considers mainly the casts. Space and material required for the various constructions are also compared. (INIS)

35388 NUCLEAR POWER PLANTS WITH FAST BREEDERS. Laue, H. (Internationale Atomreaktorbau GmbH, Bensberg, Ger.). Konstr. Ing. Ber.; No. 10, 32-43(1971). (In German).

The description of the essential characteristics of the SNR and its components is followed by a delineation of the development of the containment design. One of the most important features of the design is described which offers the possibility to control the mechanical consequences of the Bethe–Tait disturbance in the areas of reactor lid and radial shield. (INIS)

35389 DEVELOPMENT OF A HIGH-TEMPERATURE REACTOR IN THE FEDERAL REPUBLIC OF GERMANY. Schulten, R. (Kernforschungsanlage, Juelich, Ger.). Konstr. Ing. Ber.; No. 10, 44-8(1971). (In German).

A description is given of the constructional characteristics of the high-temperature reactor, citing as example the AVR reactor and its operational experience. Possibilities for further developments in connection with the high-temperature reactor are explained by referring to the application of gas turbines and to process-heat generation. (INIS)

35390 MECHANICAL PROBLEMS OF A PEBBLE BED REACTOR CORE. von der Decken, C. B. (Kernforschungsanlage, Juelich, Ger.). Nucl. Eng. Des.; 18: No. 2, 323-33 (1972). (CONF-710903–24).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The development of the pebble bed reactor requires very detailed knowledge of the behavior of the pebble bed and the influence of different parameters. In a large number of model experiments the behavior of pebble beds was studied. A survey is presented of the questions and problems and also of the status of knowledge obtained. The main problems are the following: blockage of the outlet tube, velocity distribution of the spheres during recylcing of the bed, problems of systematic orientation near the container wall due to the small tolerances of the spheres, forces on the reflector wall and core-bottom, forces caused by the adsorber rods which are pushed directly into the pebble bed, forces on the adsorber rods during recirculation of the bed. The most important parameters which influence all these effects are: the geometry, i.e. the ratio of the diameters of the outlet tube and the pebble bed to the sphere diameter ratio of diameter to height of the bed, form, inclination and number of hoppers, tolerances of the spheres, and the material data of the spheres which are used such as density strength and elasticity, in case of the reactor for graphite, in case of the models in addition for ceramic and glass. An important parameter is the friction coefficient because the friction coefficient of graphite increases by about a factor of 4 under very pure inertgas conditions such as occur during reactor operation. As it is not possible to simulate the reactor operation conditions in model experiments referring to all important parameters in one single experiment, a large number of model experiments with parameter variations were done to obtain enough information to extrapolate to reactor conditions with reasonable accuracy. The comparison of the results of the model experiments with reality was done with the operational results with the only pebble bed reactor under operation, the AVR reactor. It was shown that it is possible to predict the mechanical behavior of a pebble bed reactor core with sufficient accuracy. (auth)

35391 STUDY OF HAZARDOUS VIBRATIONS OF HYDRODYNAMIC ORIGIN OF CERTAIN STRUCTURES IN THE PHENIX REACTOR CORE. Lesueur, C. (INSA Vibrational Lab., Villeurbanne, France); Milan, D.; Payan, G. Nucl. Eng. Des.; 18: No. 2, 279-303(1972). (In French). (CONF-710903–22).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

An important source of vibrations in the vessels of a reactor such as the sodium cooled fast French reactor Phenix is the turbulence of the liquid sodium flow. In fact, the random pressure pulsations may excite the natural modes of the structures if they are within the low frequency range. An attempt was made to ascertain whether the vessels and internals of the reactor were adequately stable and if not, to determine the necessary changes to achieve this aim. (43 references) (auth)

35392 METHODS FOR CALCULATING RADIATION-INDUCED HEAT GENERATION. Chilton, Arthur B. (Univ. of Illinois, Urbana). Nucl. Eng. Des.; 18: No. 3, 401-13(1972). (CONF-710903–28).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The heat production rate at any point in a medium due to a neutron or gamma-ray field existing at that point can generally be simply related to the following quantities: the flux density energy spectrum at that point; the number density of various atomic constituents at that point; the energy-dependent atomic (microscopic) cross-sections for the various interactions possible between radiation types and nuclear species; and the kinetic energy of the resulting charged particle emissions, which are assumed to be locally transformed into thermal energy. The determination of each of these quantities is discussed. Precise knowledge of the radiation field flux density and its energy spectrum as a function of position in most practical cases requires a rather sophisticated use of one or more of the various methods of radiation transport calculation known. A brief review of these techniques and their capabilities is made. Fortunately, there are approximation formulas which are adequate for engineering purposes in many cases. Such formulas are largely based on use of the "point kernel" approach, which is strictly valid only for infinite homogeneous media; however, these are usually adequate, especially for gamma rays, which are in general of greater significance than neutrons in reactor shield heating. For gamma rays, it is the custom to combine much of the information on atomic constituents of the medium, cross-sections for the various energy-depositing interactions, and energy of the resulting charged particles (electrons) into a coefficient called the "energy deposition coefficient." The fundamental basis of energy deposition coefficients and how one might best choose the correct values to use for it are reviewed. Comparisons of predicted and measured heat production functions are able to be found in the literature and are briefly summarized. Discrepancies found indicate the degree of accuracy generally available with today's techniques. (10 references) (auth)

Physics and Core Engineering

35393 (AEEW-R–747) CALCULATION OF FUEL TEMPERATURE REACTIVITY COEFFICIENTS FOR SGHWR's. Siudek, R. S. (Atomic Energy Establishment, Winfrith (England)). Sep 1971. 35p. Dep. NTIS (U. S. Sales Only).

An investigation into the calculation of fuel temperature coefficients for SGHWR's has been undertaken as the first stage in the study of methods of calculating reactor perturbations. Some preliminary results from this investigation are described. The first part of the work is concerned with a comparison of fuel temperature reactivity coefficients as calculated by the current lattice codes for SGHWR's, METHUSELAH and WIMS. The former code was first developed in 1961 and has been used extensively in routine design and operational analysis within the project. The latter code provides an improved and more complete physical representation at the expense of an extra expenditure in computer time. A condensed version of WIMS known as MINIWIMS is being introduced to replace METHUSELAH. The second part describes the use of lattice data, generated by the above methods, in a whole reactor calculation, JOSHUA, and compares JOSHUA predictions of fuel temperature reactivity coefficients with two measurements made in the Winfrith SGHWR. (14 references) (UK)

35394 (EURFNR-966) RESULTS OF HEAT TRANSFER AND PRESSURE DROP MEASUREMENTS WITH HELIUM ON A TUBE BUNDLE. Marek, J.; Maubach, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1482. 62p. Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The results of measurements performed with respect to pressure drop and heat transfer of helium at a pressure of 40 ata flowing through a bundle of 9 tubes in a square arrangement are reported. The tubes were heated directly by direct current; the heating power was between 30 and 300 kW corresponding to a power of 16–160 W/cm at the heating tube. The tubes were smooth and arranged in a smooth square channel at a distance ratio of c/d = 1.283. The Reynolds numbers ranged between 10^4 and 3×10^5. Wall temperatures up to 700°C have been measured. The isothermal friction coefficients of the entire bundle, including the channel wall, were determined to be about 7% less than those of the circular tube. Transformed to the conditions applicable to an arrangement with an infinite number of rods, the results were about 3% less than those of the circular tube. The measured Nusselt numbers calculated for infinite arrangement are also slightly lower than the comparable values of circular tubes. An influence of the temperature factor on the Nusselt number was not observed. (auth)

35395 (HEDL-TME-72-57) COMPARISON OF TWO FAST REACTOR CROSS SECTION PROCESSING CODES. Kidman, R. B. (Hanford Engineering Development Lab., Richland, Wash.). Feb 1972. Contract AT(45-1)-2170. 58p. Dep. NTIS.

Beginning with the latest basic nuclear data available from the Evaluated Nuclear Data File (ENDF/B), a group by group comparison between two contemporary multigroup processing schemes ETOX/1DX and MC^2 is presented. Cross sections from each scheme, for a simple reactor composition, are graphically compared, displaying at once the general good agreement obtained. A relatively large Doppler effect difference is studied in detail. The results are also graphically shown providing a useful aid for understanding this sensitive nuclear parameter. According to the differences and their origins, improvements are identified that will bring the two approaches into even closer agreement. 6 references. (auth)

35396 (JAERI-M-4523) CORE DYNAMICS OF THE EXPERIMENTAL MULTI-PURPOSE HIGH-TEMPERATURE REACTOR. Ezaki, Masahiro; Mitake, Susumu; Shinoda, Wataru (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 49p. (In Japanese). NTIS (U. S. Sales Only).

Core dynamics of the experimental multi-purpose high-temperature gas cooled reactor are investigated by digital simulation methods. The accident conditions are as follows: reactivity insertion, change in the coolant flow-rate, loss of circulator power and change in the coolant inlet temperature. The reactor-core behavior is stable during accident conditions, and so the reactor can be controlled safely. The change in fuel temperature has a time delay from the change in power and so the negative temperature feedback becomes effective about 20 seconds after the reactivity insertion. In the total loss of circulator power accident, fuel and coolant outlet temperatures rise slowly and so the reactor can be protected adequately. (auth)

35397 (JAPFNR-22) STUDY OF HETEROGENEITY EFFECTS ON THE SODIUM VOID COEFFICIENTS. PART II. (Mitsubishi Atomic Power Industries, Inc., Omiya (Japan)). Translation of a Japanese report. 27p. Dep. NTIS (U. S. Sales Only).

Heterogeneity effects of neutron spectra and axial leakage are examined. Spectra in a two-region cell are computed by a collision probability method and the heterogeneity effect is found to be small. The analysis of the axial leakage is carried out with the Benoist's directional collision probability method, and the heterogeneity has negative contribution to the sodium void coefficient. The heterogeneous void coefficient in a prototype fast reactor moves towards the positive direction from the homogeneous result. (auth)

35398 (ORNL-TM-3767) HYBRID COMPUTER SIMULATION OF THE MSBR. Burke, O. W. (Oak Ridge National Lab., Tenn.). 5 May 1972. 88p. Dep. NTIS.

A hybrid computer simulation model of the reference 1000 MW(e) MSBR was developed. The model simulates the plant from the nuclear reactor through the steam throttle at the turbine. The simulation model is being used to determine the dynamic characteristics of the plant as well as to discover the problems associated with the control of the plant. 4 references. (auth)

35399 PERIODICITY IN ANNULAR DIFFUSER FLOW. Fricke, F. R. (Univ. of Southampton, Eng.). Nucl. Sci. Eng.; 48: No. 1, 87-102(May 1972).

Flow oscillations in an annular diffuser can occur which may, if either of the surfaces is free to move, cause severe vibration problems. The nature of the instability and the factors affecting it were experimentally investigated, and a method of reducing or eliminating it was sought. (15 references) (auth)

35400 DETERMINATION OF ^{238}U CAPTURE RATES IN MIXED-OXIDE FAST REACTOR LATTICES. Chawla, R.; Besant, C. B. (Atomic Energy Establishment, Winfrith, Eng.). Nucl. Instrum. Methods; 100: No. 2, 301-13(1972).

Measurements of ^{238}U capture rates (C_8), relative to ^{239}Pu fission (F_9), have been carried out in 25% and 16% PuO_2/UO_2 fuels in the fast reactor ZEBRA using Ge(Li) detectors. A number of experimental techniques have been developed and applied, with individual accuracies of better than ±2%. These methods have made possible the elimination of any unsuspected systematic errors that might arise from the simple use of UO_2 foils in mixed-oxide fueled reactor lattices. (auth)

Control and Instrumentation

35401 (ORNL-tr-2581) CORRELATIONS OF ORDERS 2-4 FOR THE TIME DISTRIBUTION OF DETECTOR PULSES. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of Chapter 7 of report INR-4/66-5. 7p. Dep. NTIS.

35402 NUCLEAR REACTOR INSTALLATIONS. (to Siemens Aktiengesellschaft). British Patent 1,271,347. 19 Apr 1972. Priority date 5 Sep 1969, Germany.

REACTOR CONTROL SYSTEMS—operating characteristics of load following
REACTORS,POWER—control system for, operating characteristics of load following, (D.C.C.)

Containment Systems, Waste Processing, and Radiation Protection

35403 GRAPHICAL ASSISTANCE TO REACTOR SHIELD DESIGN. Goddard, A. J. H.; Keillor, S. A.; Wrigley, M. F. (Imperial Coll. of Science and Tech., London). J. Brit. Nucl. Energy Soc.; 11: No. 2, 141-7(Apr 1972).

Established computing methods in reactor shield design and in interactive graphics were brought together in a long-term study aimed at reducing shield design times by means of direct man–computer interaction. One-dimensional discrete ordinate transport theory and two-dimensional diffusion theory formed the basis of the work described. (auth)

35404 THERMAL SHIELDING DEVICE FOR THE WALL OF AN ENCLOSURE. (to Compagnie Industrielle de Travaux). French Patent 2,077,825. 5 Nov 1971. Filed 17 Feb 1970. (In French).

A thermal shielding device for the wall of an enclosure subjected to high temperatures is described. It is intended, particularly, for the prestressed concrete vessels of pressurized water nuclear reactors. It consists of a closed metallic envelope parallel to the wall, a heat insulation fixed to the envelope the same side as the wall, and a system of fins between the wall and envelope. (France)

35405 CONTAINMENT SYSTEMS FOR NUCLEAR REACTORS. (to Stone and Webster Engineering Corp.). British Patent 1,270,139. 12 Apr 1972. Priority date 3 Oct 1968, United States.

REACTOR CONTAINMENT STRUCTURES—design characteristics of cone shaped concrete, for water cooled reactors
REACTORS, BOILING—containment structure for, design characteristics of cone shaped concrete
REACTORS, PRESSURIZED-WATER—containment structure for, design characteristics of cone shaped concrete, (D.C.C.)

35406 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR PRESSURE VESSELS. Errington, Thomas (to Whessoe Ltd.). British Patent 1,267,154. 15 Mar 1972. Filed 11 Feb 1970.

Reference is made to improved means for retaining heat insulation material on reactor pressure vessels and components within such vessels. Normally the insulation is retained against the surfaces to be protected by studs welded to the surfaces, and is itself protected from the reactor gas and the effect of pressure fluctuations by foils and cover plates, spaced from the surface by collars on the studs. The foils and cover plates are retained against the collars by nuts screwed on to the studs and lock welded thereto. Because the reactor gas has a corrosive effect there is a buildup of oxide on all the parts and particularly between the nut and collar, tending to push these apart. Means adopted to allow for this result in a very long stud. In the arrangement described a cover member is spaced from the surface to be insulated by the collar and retained in position relative to the surface and collar by a retaining member mounted on the collar, the insulation being located between the surface and the cover member. (UK)

35407 STRUCTURES FOR THE SAFETY OF NUCLEAR POWER PLANTS. Zerna, W. (Univ., Bochum, Ger.). Konstr. Ing. Ber.; No. 10, 87-93(1971). (In German).

Some considerations are made as to how the safety of nuclear power plants can be guaranteed by structural measures. The safety containments are discussed in particular, and concrete shields in the pressure depression system, as well as the strain by external explosion effects are investigated. It is concluded that the development has made great progress with regard to safety problems and that nuclear power plants can be considered to be the most advanced and safe industrial plants. (INIS)

35408 PRESTRESSED CONCRETE PRESSURE VESSEL FOR THE 300-MWe-THTR-NUCLEAR POWER PLANT. DESIGN AND CONSTRUCTION. Bremer, F. (Fried-Krupp GmbH, Essen). Konstr. Ing. Ber.; No. 10, 165-72(1971). (In German).

A description is given of the problems involved in design and construction, as seen from the point of view of a pressure vessel producer. The investigations of the materials behavior under mechanical loads are considered mainly. Construction and properties of the thermal insulation are described as well. (INIS)

Coolant System

Refer also to abstracts 33060 and 33123.

35409 (AEEW-M-1051) FILM BOILING ON SUBMERGED VERTICAL CYLINDERS. Bailey, N. A. (Atomic Energy Establishment, Winfrith (England)). 2 Jul 1971. 20p. Dep. NTIS (U. S. Sales Only).

An analytical model is developed for film boiling on submerged vertical cylinders and this is compared with experimental data, close agreement being obtained. An analytical model has also been developed for the behavior of the nucleate/film boiling interface on a rod which is being quenched and measurements have been made of the rate of quenching. An analytical model is developed for the heat transfer in the film boiling regime on submerged vertical cylinders and this is compared with experimental data obtained on a $\frac{1}{2}''$ diameter rod with water at atmospheric conditions. An analytical model has also been developed for the behavior of the nucleate boiling/film boiling interface which defines the rate of quenching of an overheated rod and measurements have been made of the quenching velocity (the advance of the nucleate boiling region) on the $\frac{1}{2}''$ diameter rod. (8 references) (UK)

35410 (EURFNR-904(Rev.)) INHERENT PROPERTIES OF THE VARIOUS PRIMARY CIRCUIT DESIGNS FOR SODIUM-COOLED REACTORS. Mueller, R. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-1379. 33p. Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

An analysis of the fundamental structure of the primary cooling circuit of sodium-cooled reactors is presented. Additional parameters are introduced stepwise so that the variants under consideration approach the real engineered designs. The method yields a consistent scheme comprising all possible variants up to a defined degree of refinement. The inherent properties are clearly attributed to the individual variants. All designs investigated and realized so far can be placed on specific positions in this "family tree" and thus can be definitely recognized as the specific solutions of the general system. (41 references) (auth)

35411 (RDT-E-4-6-T(1-72)) INTERMEDIATE HEAT EXCHANGER FOR LIQUID METAL SYSTEMS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Jan 1972. 48p. RSO.

The requirements are presented for liquid metal-to-liquid metal heat exchangers designed and constructed to Code Class 1 requirements of the ASME Boiler and Pressure Vessel Code, Section III, Nuclear Power Plant Components, and special requirements that are additive or more restrictive. Shell-and-tube "intermediate" heat exchangers used to transfer heat between the primary and secondary liquid metal coolants of reactor heat transport systems are included. (auth)

35412 (WAPD-TM-1000(Vol.2)) HEAT TRANSFER AND FLUID FLOW WITH APPLICATIONS TO PRESSURIZED WATER REACTORS. VOLUME II. CHAPTER 3. FLUID DYNAMICS. CHAPTER 4. HEAT TRANSFER IN FLUIDS. CHAPTER 5. TWO-PHASE HEAT TRANSFER AND FLUID FLOW. CHAPTER 6. HEAT TRANSFER BY RADIATION. Pfennigwerth, P. L.; Minkler, Bill (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan 1971. Contract AT-11-1-GEN-14. 218p. Dep. NTIS.

Information on heat transfer and fluid flow characteristics of pressurized water reactors is presented under the following topics: equations for fluid velocity fields; inviscid flow; dimensional analysis; laminar flow; turbulent flow; one-dimensional conservation laws for reactor channels; energy and enthalpy equations; heat transfer in laminar flow; heat transfer in turbulent fluids; two-phase flow; heat transfer with boiling; void fractions and two-phase pressure losses; thermal radiation; and heat exchange calculations in non-absorbing media. (D.C.C.)

35413 EQUIPMENT FOR MEASURING LEVELS (PARTICULARLY THOSE OF LIQUID Na, IN A REACTOR VESSEL). Spiteri, Pierre (to Electricite de France). French Patent 2,074,798. 8 Oct 1971. Filed 29 Jan 1970. (In French).

A cut-off level gage (intended particularly for measurements of the level of liquid Na inside a reactor vessel) is described. An electrical bridge circuit corrects the effects of ambient temperature on the triggering of the signal from which the level is obtained. The apparatus is simple, rugged, and compact. The level is measured in terms of a sharp variation in the electrical signal, which is unaffected by liquid aerosol deposits on the device immersed in the vessel. (France)

35414 LIQUID-METAL HEAT TRANSFER AND FLUID DYNAMICS. Winter Annual Meeting of the American Society of Mechanical Engineers, New York, New York, November 30, 1970. Chen, John C.; Bishop, A. A. (eds.). New York; American Society of Mechanical Engineers (1970). 184p. $23.50. (CONF-701150).

Included are 18 papers on liquid metal heat transfer and fluid dynamics. A separate abstract was prepared for each paper. (J.M.J.)

For abstracts of individual papers see: 33275–33285, 35415, 35416, 35448, and 35635–35638.

35415 EXPERIMENTAL AND ANALYTICAL INVESTIGATIONS OF SODIUM BOILING EVENTS IN NARROW CHANNELS. Peppler, W.; Schlechtendahl, E. G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 162-71 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

Particular attention was given to nucleation, growth and shrinking of sodium vapor bubbles in the case of a partial or complete blockage of flow in a fuel element under power conditions. As far as the safety aspects are concerned the problems connected with partial or complete flow blockages are solved with sufficient accuracy. Recent research work is directed to the unsolved problems of local flow blockages and local boiling in fuel elements. Basic research work is carried out on the still unknown superheat behavior of sodium and specific questions in respect to stable or unstable boiling of sodium. (34 references) (auth)

35416 FORCED CONVECTION BOILING OF SODIUM IN A NARROW CHANNEL. Costa, J.; Charlety, P. (CEN, Grenoble, France). pp 172-8 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

Experimental results of a study of forced convection boiling of sodium are presented. The tests have been performed under boundary conditions representative of those in a liquid metal cooled fast breeder reactor (LMFBR). Steady state boiling occurred and the pressure drop characteristics of the test section (ΔP versus mass flow-rate or "S" curve) have been measured. A method using two electromagnetic flowmeters has been used to determine the void fraction and the vapor quality of the two-phase flow. The experimental results are compared with the calculated pressure profile. (14 references) (auth)

35417 PRACTICAL APPLICATION OF FRACTURE MECHANICS TO PRESSURE-VESSEL TECHNOLOGY. Conference Held at London, England, May 3–5, 1971. London; Institution of Mechanical Engineers (1971). 319p. £15. (CONF-710534).

Thirty-three papers were presented at the conference. Six papers are within the scope of NSA and separate abstracts were prepared for these. (UK)

For abstracts of individual papers see: 33303, 33974, and 35418–35421.

35418 FRACTURE MECHANICS TECHNOLOGY AS APPLIED TO THICK-WALLED NUCLEAR PRESSURE VESSELS. Wessel, E T. (Westinghouse Research Labs., Pittsburgh); Mager, T. R. pp 17-27 of Practical Application of Fracture Mechanics to Pressure-Vessel Technology. London; Institution of Mechanical Engineers (1971).

From Conference on practical application of fracture mechanics to pressure-vessel technology; London, England (3 May 1971). See CONF-710534.

The applicability of fracture mechanics technology for the prevention of fracture of large nuclear pressure vessels is described in terms of the basic concepts involved, the type of information required, the data currently available, and how this information is employed for engineering purposes. The interdisciplinary nature of the technology is emphasized and described. It is concluded that the technology is sufficiently well established to be of practical engineering value. (auth)

35419 USE OF LINEAR-ELASTIC FRACTURE MECHANICS IN SAFETY ANALYSIS OF HEAVY-SECTION NUCLEAR REACTOR PRESSURE VESSELS. Mager, T. R.; Riccardella, P. C. (Westinghouse Electric Corp., Pittsburgh). pp 56-64 of Practical Application of Fracture Mechanics to Pressure-Vessel Technology. London; Institution of Mechanical Engineers (1971).

From Conference on practical application of fracture mechanics to pressure-vessel technology; London, England (3 May 1971). See CONF-710534.

Linear-elastic fracture mechanics technology was employed to demonstrate the integrity of heavy-section nuclear reactor pressure vessels. It was demonstrated that the technology, when properly applied, can provide quantitative answers to practical problems. The utilization of linear-elastic fracture mechanics to nuclear reactor pressure vessel safety requires interrelationship of defect characterization, prevailing stresses during operation, and the vessel's material properties. Material properties considered were the fracture toughness K_{Ic} (stress intensity factor) for unirradiated and post-irradiated (5×10^{19} N/cm^2, E > 1 MeV) conditions, and the fatigue crack growth rate as a function of the change in stress intensity, ΔK_I. The application of these parameters in conjunction with the normal light water reactor coolant system design transients for a typical pressurized water reactor demonstrated that an initial allowable flaw size that could exist at the start of life would not grow to a critical size during the design lifetime of the nuclear reactor pressure vessel (40 years). (auth)

35420 FRACTURE CONTROL PROCEDURE FOR A NUCLEAR PRESSURE VESSEL. Egan, G. R.; Harrison, J. D. (Welding Inst., Abington, Eng.). pp 129-35 of Practical Application of Fracture Mechanics to Pressure-Vessel Technology. London; Institution of Mechanical Engineers (1971).

From Conference on practical application of fracture mechanics to pressure-vessel technology; London, England (3 May 1971). See CONF-710534.

A fracture control procedure for nuclear pressure vessels is proposed on the basis of full plate thickness crack opening displacement tests and crack growth rate data from compact K specimens. This approach is compared with a method of analysis based on Charpy V notch impact tests and it is shown that not only is the Charpy V notch impact test approach insensitive to material thickness but it is also insensitive to the degradation of material properties with temperature. The pressure vessel under consideration should be over-pressure tested at 150°C, and after such treatment it is unlikely that the application of cyclic stresses caused by starting up and shutting down will lead to significant crack growth in the life of the plant. The interval between the initial pressure test and any subsequent test is, therefore, determined by a consideration of the rate of degradation of material properties by radiation damage rather than by the rate of growth of cracks in service. The implications of using a fracture control procedure when the material is very tough at the proof test temperature are also discussed, and it is concluded that initial assessments of pre-existing flaw size may need to be based on the limits of non-destructive testing techniques. (auth)

35421 SAFETY EVALUATION OF NUCLEAR REACTOR PRESSURE VESSELS FOR PRESSURIZED WATER REACTORS. Bartholome, G.; Dorner, H. (Siemens AG, Erlangen, Ger.). pp 175-82 of Practical Application of Fracture Mechanics to Pressure-Vessel Technology. London; Institution of Mechanical Engineers (1971).

From Conference on practical application of fracture mechanics to pressure-vessel technology; London, England (3 May 1971). See CONF-710534

An evaluation of the safety of nuclear reactor pressure vessels for pressurized water reactors to resist fracture is an important feature in ensuring nuclear reactor safety. This evaluation is performed using fracture mechanics. The basic theory of fracture mechanics is presented and the technical application of fracture mechanics to nuclear reactor pressure vessels is discussed. Finally, these are comments on the evaluation of the safety of reactor pressure vessels against fracture. (auth)

35422 COST OF COOLING STEAM TURBINES. Hauser, L. G. Energ. Nucl. (Paris); 13: No. 6, 444-6(Nov-Dec 1971). (In French).

A comparison is made between the cost of cooling fossil fuel power plants and nuclear fuel power plants. The economics of the choice of cooling water feed system and site are studied. (France)

35423 BOILER SYSTEMS FOR PRODUCING STEAM. Charcharos, Anthreas Nicholas; Williamson, Clifford (to British Nuclear Design and Construction Ltd.). British Patent 1,269,651. 6 Apr 1972. Filed 14 Feb 1969.

Conventional boiler systems for use with nuclear reactors are briefly described and their disadvantages discussed. The system described comprises an economizer, evaporator and superheater water/steam tube sections located in the boiler casing, the economizer and evaporator tube sections being connected end to end within the casing. A steam drum is located outside the casing, arranged to receive steam/water from the evaporator section and to release steam to the superheater section. A mixing device is also located outside the casing, arranged to receive water from the steam drum via a recirculating pump, and from a boiler feed line, and to feed the mixed water to the economizer and evaporator sections for circulation there through. A further connection is preferably provided for feeding water directly from the boiler feed line to the steam drum, this including valve means arranged to be controlled depending on water level in the steam drum, to assist in maintaining the water level between preselected upper and lower limits. Such a system necessitates only four perforations of the boiler casing and the reactor pressure vessel wall. It also affords a reverse of water that can be fed not only to the evaporator section in the event of failure of the boiler feed water line, but also to the economizer section, thereby protecting the economizer from thermal distortion and, in the event of a reactor trip, providing additional cooling surface for removal of heat from the reactor coolant without immediate resort to an emergency source of water. The system also provides forced recirculation through both evaporator and economizer sections, such that stability of water/steam flow is more easily secured, even at low reactor heat outputs. In operation of the system a heat exchange medium flows upward through the boiler casing and steam/water flows downwards through the tube sections. (UK)

35424 INSULATION, LINER, AND COOLING SYSTEM FOR THE PRESTRESSED CONCRETE PRESSURE VESSEL OF THE 300-MWe-THTR-PROTOTYPE POWER PLANT. Lotz, H.; Schwiers, H. G.; van der Weyden, H. D. (Brown Boveri/Krupp Reaktorbau GmbH, Mannheim, Ger.). Konstr. Ing. Ber.; No. 10, 173-84(1971). (In German).

A description is given of the constructional features belonging to three partial functions of the prestressed concrete pressure vessel. Construction, manufacturing and mounting of the liner are outlined. Design and calculation of the heat protective system are described. This system is composed of cooling system (system on the outer side of the liner, inside the concrete) and insulation (on the inner side of the liner). (INIS)

35425 DESIGN CRITERIA FOR PRESTRESSED CONCRETE REACTOR PRESSURE VESSELS. Zerna, W. (Univ., Bochum, Ger.). Konstr. Ing. Ber.; No. 10, 132-9(1971). (In German).

A prestressed concrete pressure vessel differs from conventional prestressed concrete buildings particularly because of its three-axial stress and its special strain conditions. A distinction is made between the working state with admissible stresses and one or several hypothetical limit states from which then the safety factors against vessel failure can be calculated. Most important results of investigations for the establishment of design criteria, some of them completely new, are given. These briefly discussed criteria were applied in the licensing procedure for the pressure vessel of the Schmehausen THTR. (INIS)

35426 OVERLOAD DESIGN FOR PRESTRESSED CONCRETE PRESSURE VESSELS. Stangenberg, F.; Schnellenbach, G.; Schimmelpfennig, K. (Univ., Bochum, Ger.). Konstr. Ing. Ber.; No. 10, 123-31(1971). (In German).

A description is given of the method of kinematic rupture models used for the determination of the critical load, illustrated by some examples. The THTR-vessel is treated as a special case as it requires the additional determination of critical deformation of the liner and its consequences on the liner integrity. (INIS)

35427 MATERIAL BEHAVIOR OF STEEL AND CONCRETE IN PRESTRESSED CONCRETE PRESSURE VESSELS: MATERIAL DATA INVESTIGATIONS AND ASSUMPTIONS FOR ANALYSIS. Hansson, V.; Schimmelpfennig, K. (Univ., Bochum, Ger.). Konstr. Ing. Ber.; No. 10, 102-12(1971). (In German).

A survey is given on the special material properties with a view to the particular operating conditions of the prestressed concrete pressure vessels, as well as on investigation results obtained up to now, and design criteria and calculation assumptions regarding the material behavior. These data refer to designs with temperatures of the concrete reaching approximately 40 to 70°C at the liner interface, and with the reactor core being surrounded by a thermal shield in order to protect both liner and concrete against radiation damages. (INIS)

35428 COMPARISON OF HELIUM AND CO_2 AS REACTOR COOLANTS. Lyall, H. G. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Energy; 26: No. 2, 49-60 (Feb 1972).

Gas-cooled reactors with pin-cluster type fuel in axial flow are considered. Expressions are developed for the pumping power to circulate the coolant through the reactor core, for the core flow area to give a particular heat transfer performance and for the gas forces on the fuel elements. With the assumption that the heat transfer surface area is kept fixed, but that the flow area is variable, fluid property terms are separated out from these expressions and used to compare CO_2 and helium. It is shown that at the operating conditions of advanced gas-cooled reactors, helium requires less pumping power than CO_2 and produces substantially lower gas forces. However, it does require somewhat more core flow area. (auth)

35429 METHODS OF PURIFYING SODIUM. Coron, J.; Lecocq, P. (Electricite de France, Chatou). Energ. Nucl. (Paris); 13: No. 6, 428-35(Nov-Dec 1971). (In French).

A bibliography of the problems connected with the purification of Na is presented. A list is given of the main impurities found in the Na of coolant circuits. Their origin and consequences are examined, and the various ways of continuously purifying the circulating Na are discussed. Particular attention is given to cold trap purification. (France)

35430 DESIGN AND FABRICATION OF REACTOR PRESSURE VESSELS FOR LIGHT WATER REACTORS. Bonka, H. Energ. Tech.; 23: No. 8, 272-7(1971). (In German).

From the point of view of reactor safety, the pressure vessels are considered to be the most important reactor components of the light-water reactor line which predominates the scene in the Federal Republic of Germany. An excerpt from a doctoral thesis summarizes the essential characteristics as to the safety of reactor pressure vessels in nuclear power plants. Apart from outlining the dimensions of present reactor pressure vessels, materials selection and measurement of tensile stresses, a description of the fabrication processes is given. Because of the large size and high weight of the several plates and forgings there are two different ways of welding the parts together, depending on the thickness of the pieces, namely either the submerged arc welding, or else the electro-slag welding procedure. The fabrication of pressure vessels for the pressurized water reactor in Biblis and for the boiling water reactor in Wuergassen is described in detail. An extensive bibliography is listed. (INIS)

35431 TEMPERATURE DISTRIBUTION ALONG A TUBE CONTAINING A FLOWING FLUID. Rysy, W. (Hochtemperatur-Reaktorbau GmbH, Cologne). Atomkernenergie; 19: No. 3, 237-40(May 1972). (In German).

A differential equation is derived and its solution is given, by which the temperature distribution along a tube containing a stagnant or flowing fluid can be evaluated. As an example, a computation and a diagram are given for the temperature distribution in the fuel element circulating system of the Thorium High Temperature Reactor. (4 references) (auth)

Fuels and Fuel Elements

Refer also to abstracts 33191 and 33243.

35432 (ANL-7795) CAPTURE-TO-FISSION RATIO MEASUREMENTS OF ^{239}Pu AND ^{241}Pu FROM IRRADIATION OF CAPSULES IN THE EBWR. Iskenderian, Haig P.; Wahlgren, Morris A. (Argonne National Lab., Ill.). Dec 1971. Contract W-31-109-eng-38. 30p. Dep. NTIS.

Planning of an irradiation experiment in the EBWR for the determination of capture-to-fission ratio, α, of plutonium-239 and of plutonium-241 involved hydrodynamic and heat-transfer calculations to ensure that there would be no undue hot spots involved as a result of experimental arrangement. Calculations were verified experimentally prior to exposure runs in the reactor. Mathematical expressions for α^{Pu}, in terms of initial weight measurements and mass-spectrometric and radiochemical data, are given. A discussion of experimental results and of error is also given. Interpolation of results for bare and cadmium-covered samples to obtain α^{Pu} at thermal energies indicate good agreement with current data at 0.0253 eV. 8 references. (auth)

35433 (ANL/EBR-49) SUBASSEMBLY TEMPERATURES DURING POSTIRRADIATION TRANSFER FROM THE EBR-II PRIMARY TANK. Sackett, J. I.; Perry, W. H.; Cook, J. H.; Cushman, R. A. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Mar 1972. Contract W-31-109-eng-38. 54p. Dep. NTIS.

The cooling capability of the fuel-transfer system was determined for the types of subassemblies now in use at EBR-II. This was done to provide expected subassembly temperatures during transfer from the primary tank and to allow a more flexible transfer schedule than the 15-day holding period initially set. It was found that there is a wide variation in heat-transfer characteristics of subassemblies because of differences in element or capsule configuration and flow orificing. To maintain cladding surface temperatures within the desired range, the allowable decay-heat generation is generally well below 1.0 kW. The temperature rise on loss of cooling also varies significantly with subassembly configuration and composition, and may be the limiting factor in determining the holding period for some subassemblies. A recently developed computer program, DECAY, provides curves of maximum temperatures during transfer vs postirradiation holding time, for fueled subassemblies. The tables and nomograms that have been developed from these results give holding-time requirements of subassemblies as a function of their power generation while in the core. Structural subassemblies have also been examined. Most structural materials cause no serious heating problems during transfer. A few, however, have significant decay-heat production that must be considered carefully during design. 12 references. (auth)

35434 (CONF-710443) MOLTEN-SALT REACTOR PROGRAM. Semiannual Information Meeting, April 20, 1971, Oak Ridge, Tennessee. Summaries of the ORNL Presentations. (Oak Ridge National Lab., Tenn.). 1971. 113p. Dep. NTIS.

BERYLLIUM FLUORIDES—BeF_2–LiF–ThF_4–UF_4, heat transfer characteristics of
BOILERS—development program for molten salt breeder reactor
FISSION PRODUCTS—deposition of noble metal, in molten salt reactors
  —transport of noble metal, in molten salt reactors
FUSED SALTS—processing of, fabrication of test equipment for
  —processing methods for, development of chemical
GRAPHITE—radiation effects on expansion of, fast neutron
HASTELLOY N—radiation effects on mechanical properties of, thermal neutron
LITHIUM FLUORIDES—BeF_2–LiF–ThF_4–UF_4, heat transfer characteristics of
MOLTEN SALT BREEDER REACTOR—fuel salt for, heat transfer characteristics of
  —design parameters for demonstration 300 MW(e)
  —radioactive waste disposal system for, development of off-gas
  —coolant salt for, test loop program for secondary
  —steam generators for, development program for
  —fuel salt for, development of helium bubble generator and separator for
  —tritium in 1000 MW(e), chemical methods for transport control of
  —fuel salt for, chemical processing methods for
MOLTEN SALT REACTOR EXPERIMENT—operation of, review of
  —fission products in, deposition and transport characteristics of noble metal
  —control rod thimble for, thermal neutron radiation effects on mechanical properties of Hastelloy N
NEUTRONS, FAST—effects on expansion of graphite
NEUTRONS, THERMAL—effects on mechanical properties of Hastelloy N
RADIOACTIVE WASTE—disposal system for molten salt breeder reactor off-gas

THORIUM FLUORIDES ThF_4 — BeF_2–LiF–ThF_4–UF_4, heat transfer characteristics of
TRITIUM — transport in molten salt breeder reactor cooling systems, chemical methods for control of
URANIUM FLUORIDES UF_4 — BeF_2–LiF–ThF_4–UF_4, heat transfer characteristics of
XENON ISOTOPES Xe-135 — removal from molten salt fuels, effectiveness of helium bubbles for (D.C.C.)

35435 (EURFNR–969) FAST REACTOR PROGRAMME. First Quarter 1971 Progress Report. Hoekstra, E. K. (comp.) (Reactor Centrum Nederland, Petten). Oct 1971. 114p. (RCN–156). Dep. NTIS (U. S. Sales Only).

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Information on the development of liquid sodium cooled fast reactors is presented under the following topics: reactor physics; fuel irradiations; advanced fuels; radiation damage in canning materials; analysis of impurities in sodium; aerosol research; and heat transfer and hydraulics. (D.C.C.)

35436 (RD/B/N–2131) PLUTONIUM ENRICHED FUELS FOR A MK. III GCR. Jones, P. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan 1972. 37p. Dep. NTIS (U. S. Sales Only).

Results are presented of a number of ARGOSY calculations on the use of Magnox and AGR discharge plutonium as an enrichment for natural uranium in the interacting tubular design of a Mk. III GCR. An assessment of the reactivity take-up in nuclides such as Am, Np and Cm, which are not considered in ARGOSY, indicates that for these fuels the ARGOSY time-averaged reactivity should be reduced by about 400 mN. At low load factors the correction may be a factor of 2 or 3 larger. The results of these calculations are used as a basis for a discussion of the economics of plutonium enrichment of the initial charge and feed fuel of a Mk. III. (auth)

35437 (RDT–P–4-1-T(3-72)) ELECTRIC HEATERS–SIMULATED LMFBR FUEL PINS. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 19p. RSO.

The performance, materials, fabrication method, inspection and test, and quality assurance requirements for electric heaters simulating LMFBR fuel pin configurations which are used for heat transfer and other studies related to liquid metal cooled nuclear fuel are presented. (auth)

35438 (WCAP–3385-56(Pt.1)) SAXTON CORE II FUEL PERFORMANCE EVALUATION. PART I. MATERIALS. Smalley, W. R. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.). Sep 1971. Contract AT(11-1)-3044. 122p. Dep. NTIS.

The materials evaluation of irradiated fuel from the plutonium region of Saxton Core II is presented. The design, fabrication, and operating history of this core are reviewed. The evaluation of fuel materials performance as determined by both non-destructive and destructive examinations after irradiation to a wide range of burnups is presented. The inspection of selected rods from Core II prior to their reconstitution in seven new "loose lattice" assemblies to be irradiated as part of an extended burnup program in Core III is summarized. (20 references) (auth)

35439 PERFORMANCE ASPECTS OF THE FUEL CYCLE IN A MARK II GAS COOLED REACTOR. Day, J. W.; Vaughan, R. I. (Central Electricity Generating Board, London). J. Brit. Nucl. Energy Soc.; 11: No. 2, 155-64(Apr 1972).

The final selection of the initial fuel loading and of the feed fuel quantities and enrichments for an advanced gas cooled reactor require calculations to ensure that full power will be achievable from start of life to fuel cycle equilibrium under conditions such that the fuel will achieve its design life. The principal calculations that were made for the Hinkley Point B reactor to ensure that this objective was attained are presented. (auth)

35440 METHODS FOR STUDYING FUEL MANAGEMENT IN ADVANCED GAS COOLED REACTORS. Buckler, A. N.; Griggs, C. F.; Tyror, J. G. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 2, 148-54 (Apr 1972).

The methods used for studying fuel and absorber managment problems in AGR'S are described. They are based on the use of ARGOSY lattice data in reactor calculations performed at successive times steps. For advanced design calculations a detailed channel by channel representation of the whole core is required, and such an advanced approach using the ODYSSEUS-6 code, is discussed in detail. This code evaluates reactor power distribution as a function of time and uses the information to select refuelling moves and determine controller positions. (auth)

35441 NUCLEAR FUEL ASSEMBLY. Cayol, Andre; Chalony, Andre; Clottes, Georges; (and others) (to Commissariat a l'Energie Atomique). French Patent 2,069,948. 10 Sep 1971. Filed 12 Dec 1969. (In French).

A type of nuclear fuel assembly for high power density nuclear reactors (e.g. liquid metal cooled breeder reactors) is presented. Each assembly contains at least one canned bundle of fuel pins (fissile or fertile) situated in a regular lattice in an envelope cooled by circulating coolant. The fuel pins are separated by a spacing device (small diameter tubing or finning wound around the pins, the pitch angle being large). This spacing provides radial projections for pins lateral to the bundle; these projections are smaller at the places where the pins press against the envelope. When helical tubing is used as the spacer it may be flattened at the points of contact with the envelope, thus facilitating a reduction in the flow along the periphery subchannels and permitting the same output temperature to be obtained at all the channel exits (periphery and central). (France)

35442 THEORETICAL HEAT TRANSFER PREDICTIONS FOR FINITE NUCLEAR FUEL ROD ASSEMBLIES. Ginsberg, T.; France, D. M. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 48: No. 1, 103-14(May 1972).

Temperature distributions in an idealized nuclear fuel assembly were computed and studied parametrically. The assembly, which consists of a square array of spacer-free fuel elements, is bounded by an assembly wall and is cooled by longitudinal liquid metal flow. A single-region multicell analysis is used to predict the influence of the fuel assembly wall on the temperature distributions and Nusselt numbers in the idealized assembly. An analytical series solution method couples adjacent cellular temperature-field solutions, and boundary conditions on these and other irregular boundaries are satisfied using a least-squares matching technique. Two slug flow coolant models are considered in the analysis. A global slug flow model assumes a uniform coolant velocity. A cellular slug flow model assigns to each cell a velocity based on its hydraulic diameter. Results of this analysis show that the temperature distributions across the fuel assembly and around each individual fuel element are most strongly influenced by the cellular mass flow rate distribution, which is characterized by a single parameter — the cellular mass flow rate ratio. Fuel assembly temperature gradients are minimized if this ratio is chosen equal to unity. Computations of cellular Nusselt numbers indicate that while steep thermal gradients may exist across the fuel assembly, the Nusselt numbers of all but the cell closest to the wall are unaffected by the presence of the wall. Cellular nusselt numbers, cellular coolant bulk temperatures, and fuel-element wall temperatures are presented for a range of pitch-to-diameter and cellular mass flow rate ratios. (14 references) (auth)

35443 NUCLEAR REACTORS. Parkinson, Alan (to United Kingdom Atomic Energy Authority). British Patent 1,267,367. 15 Mar 1972. Filed 13 Aug 1968.

Reference is made to reactors of the type wherein coolant is conducted in heat exchange with fuel contained in tubes arranged in rows and passing with clearance through calandria vessels containing moderator and shielding material. In such reactors it is common practice to provide composite tubes comprising a center section of material, such as Zr alloy, of low neutron absorption for location within the core. These sections may deteriorate in use, necessitating replacement, and withdrawal problems arise, necessitating difficult cutting and welding operations. In the arrangement described tubular "stools" are interposed between support means on the tubes and outer face of the calandria vessel, and coolant outlet pipes extending from the outer ends of the tubes to circulating means are laid in banks between the rows of tubes and between the outer face of the calandria vessel and the support means. The provision of these "stools" lifts the support means to an accessible position above the core so that, by cutting, the tube can be released and removed from above the reactor core. The tubes are preferably vertically disposed. (UK)

35444 FUEL CYCLE. Simonovitch, G. Energ. Nucl. (Paris); 13: No. 6, 401-11(Nov-Dec 1971). (In French).

An analysis of papers written on the fuel cycle is presented. Four important subjects are considered: requirements and resources, fuel elements, reprocessing, and isotope separation. (France)

35445 NUCLEAR REACTOR CORE AND SHROUD. (to Combustion Engineering, Inc.). British Patent 1,271,594. 19 Apr 1972. Priority date 16 Jul 1969, United States.

REACTORS, PRESSURIZED-WATER — core shroud for, design characteristics of annular (D.C.C.)

35446 IMPROVEMENTS IN AND RELATING TO NUCLEAR FUEL ELEMENTS. Dieumegard, Max (to Commissariat a l'Energie Atomique). British Patent 1,271,574. 19 Apr 1972. Priority date 23 Jul 1968, France.

REACTOR FUEL ELEMENTS—design characteristics of vented, for liquid metal cooled fast reactors
REACTORS, FAST—fuel elements for liquid metal cooled, design characteristics of vented
REACTORS, LIQUID METAL-COOLED—fuel elements for fast, design characteristics of vented (D.C.C.)

35447 IMPROVEMENTS IN OR RELATING TO SLEEVED FUEL ASSEMBLIES. Tennyson, Claudius; Tyrrell, Joseph Francis (to British Nuclear Design and Construction Ltd.). British Patent 1,265,964. 8 Mar 1972. Filed 9 Apr 1968.

Reference is made to assemblies in which the fuel is supported at spaced positions within a sleeve of moderator material through which coolant is fed during operation of the reactor. Disadvantages of conventional assemblies having a tie-rod that passes axially through the center of the sleeve with a grid secured to its bottom for raising or lowering the assembly are mentioned. The assembly described includes a transversely extending support member, with a number of tie-rods extending vertically outside the assembly and attached at their lower ends to the support member and at their upper ends to lifting means. Preferably there are three tie-rods spaced equidistant around the assembly, and grooves are formed in the outer surface of the sleeve to accommodate the tie-rods. Where the reactor is of the re-entrant gas cooled type the tie-rods may conveniently extend to a point above the level of the fuel and below the level at which the coolant enters the fuel channel. Zr alloy is a suitable material for the tie-rods. The upper surface of the support member may include a raised spherical portion for engagement with the lower end of the assembly to permit the support member to pivot relative to the assembly and allow tension in the tie-rods to become substantially equalized. (UK)

35448 DEVELOPMENT AND RESULTS OF AN ELECTRICALLY HEATED SEVEN-PIN BUNDLE ASSEMBLY THERMAL HYDRAULIC TESTING IN LIQUID METALS. Collingham, R. E.; Yatabe, J. M.; Hill, V. R.; Thorne, W. L.; Creer, J. M. (WADCO Corp., Richland, Wash.). pp 41-9 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

The development, design and results of an electrically heated 7-pin instrumented bundle assembly for LMFBR thermal hydraulic testing are described. The test assembly operated in liquid metals at typical coolant temperatures (800°F) and nominal heat fluxes (500,000 Btu/hr-ft^2) of LMFBR's and was typical of LMFBR geometry. Wire wraps were used as spacers. Heat transfer data was taken over a tenfold range of Peclet number (50 to 500), and the results are presented as local coolant enthalpy rises, local coolant temperatures and local clad temperatures. Even though considerable forced diversion of the coolant by the wire wraps was evident, significant coolant and clad temperatures gradients did exist across pins of the outer row. Severe hot spots did not exist beneath a wire wrap. (auth)

35449 GRAPHITE FUEL ELEMENT STRUCTURES FOR HIGH TEMPERATURE GAS-COOLED REACTORS. Head, J. L. (Imperial Coll. of Science and Tech., London); Kinkead, A. N. Nucl. Eng. Des.; 18: No. 1, 115-44(1972). (CONF-710903—17).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Core and fuel element structures proposed for the high temperature gas-cooled reactor are described and methods of thermal and structural analyses which have been used in support of these proposals are discussed. Representative results of thermal and structural analyses are included. (59 references) (auth)

35450 FORMULATION OF PROBABILISTIC VISCO-ELASTIC MODELS FOR THE LONG-TERM DEFORMATION OF REACTOR FUEL ELEMENTS. Wang, P. Y.; Valentin, R. A. (Argonne National Lab., Ill.). Nucl. Eng. Des.; 18: No. 1, 97-114(1972). (CONF-710903—16).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The use of visco-elastic models in conjunction with random loading is examined as a possible method for determining qualitative features of the long-term, non-swelling, strain response of fuel pins. Emphasis is placed on the assumptions necessary to produce such models, their formulation, the analytical problems resulting from the assumed form of the stress process, and the sensitivity of certain results to details of the assumed visco-elastic models. For example, an examination is made of the expectation value of the difference between the predicted strain using the total history and that obtained using only the recent past. Thus, given a bound on how accurately one wishes to measure final strain, there exists a bound on how far back in time it is necessary to consider the load history. (7 references) (auth)

35451 LIFE-II: A COMPUTER ANALYSIS OF FAST-REACTOR FUEL-ELEMENT BEHAVIOR AS A FUNCTION OF REACTOR OPERATING HISTORY. Jankus, V. Z.; Weeks, R. W. (Argonne National Lab., Ill.). Nucl. Eng. Des.; 18: No. 1, 83-96(1972). (CONF-710903—15).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The LIFE-II computer code provides a detailed thermal, radiation, and mechanical analysis of cylindrical fast-reactor fuel-element behavior as a function of the actual reactor operating history. Materials behavior models of the effects of fuel restructuring, fuel cracking and hot pressing, migration of fuel constituents, fuel swelling due to solid and gaseous fission products, fission-gas release, fuel-cladding interactions, and cladding swelling due to void nucleation and growth are included in a generalized plane-strain iterative procedure. As a result, LIFE-II predicts the thermo-elastic, creep, and swelling deformations of the fuel element as a function of the reactor power and coolant temperature history. Comparison of LIFE-II calculations with results from actual fuel-element irradiations in the EBR-II reactor demonstrate the sensitivity of fuel-element performance to reactor operating cycles. Sensitivity analyses are also being performed to indicate the most critical areas in which improved fuel-element material and performance data are needed. The LIFE-II code is a realistic and versatile design tool for the prediction of fast-reactor fuel-element behavior. (25 references) (auth)

Operation and Economics

35452 DESIGN OF NUCLEAR PLANT FOR MAXIMUM AVAILABILITY. Waddington, J. S. (Central Electricity Generating Board, Berkeley, Eng.); Whitmarsh-Everiss, M. J. pp 485-500 of Thermal Stresses and Thermal Fatigue. /Littler, D. J. (ed.). London; Butterworths (1971).

From Thermal stresses and thermal fatigue conference; Berkeley Castle, England (22 Sep 1969).

Consideration is given to the design of an AGR power plant to meet a given dynamic criterion necessitated by the requirements of grid system security. A given plant configuration is required to operate within the constraint boundaries imposed by the limitations of the materials employed and with an operational margin to the plant protection system. It is necessary to optimize the control system within this constraint envelope in such a way that plant life is a maximum and any loss of revenue due to failure of plant is a minimum. To satisfy this design requirement it is necessary to predict over the thirty years' plant life the input forcing function history to the plant in order to establish the relative significance of each of the constraints. This information may be used as input to plant damage models to assess and re-optimize the controller configuration as necessary. Current calculations suggest that the plant constraint boundaries conflict and so it is not possible to organize the control system for maximum endurance of each plant component. The final control system configuration which ensures maximum plant availability and minimum loss of revenue must, therefore, take account of component endurance and cost of component failure. In order to do this, adequate experimentally correlated endurance models for the various plant components require urgent development. (auth)

Safety and Siting

35453 (BAW-10031) REFLOOD: DESCRIPTION OF MODEL FOR MULTINODE CORE REFLOOD ANALYSIS. Bingham, B. E.; Shieh, K. C. (Babcock and Wilcox Co., Lynchburg, Va. Nuclear Power Generation Dept.). Oct 1971. 32p.

The REFLOOD computer program was developed to study the dynamic behavior of reactor core refill transients following a loss-of-coolant accident. A nine-region model has been developed to simulate the refill transients. The program calculates flows, inventories, temperatures, and pressures in the primary system during reflooding. The derivation of basic equations, nodal descriptions of the primary system, and the basic assumptions used are included. 7 references. (auth)

35454 (COO-2152-3) INVESTIGATION OF PRESSURE DROPS AND HEAT TRANSFER COEFFICIENTS FOR LOSS OF COOLANT EVALUATIONS. Quarterly Progress Report for Period Ending March 31, 1972. Weisman, Joel (Cincinnati Univ., Ohio. Dept. of Chemical and Nuclear Engineering). Contract AT(11-1)-2152. 10p. Dep. NTIS.

The investigation of the pressure drop and heat transfer phenomena of importance during a loss of coolant accident is described. The study is divided into three major experiments: transient pressure drop investigation; two-phase pressure drop and flow pattern study; and transition boiling and reflooding heat transfer tests. 7 references. (auth)

35455 (IAE-2074) THEORETICAL STUDY OF THE SAFETY OF FAST NEUTRON REACTORS DURING ACCIDENTAL INTRODUCTION OF EXCESSIVE RADIOACTIVITY. Kovalevich, O. M. (Institut Atomnoi Energii, Moscow (USSR)). 1971. 52p. (In Russian). Dep. NTIS (U. S. Sales Only).

The physical and mathematical formulation of the problem of an uncontrolled power excursion in a fast neutron reactor in the form of an explosion is examined. The movement of shielding is considered and the effects on the structural members of the reactor are evaluated. Examples of numerical calculations by computer illustrate the influence of various parameters on the net result. (tr-auth)

35456 (IRS-F-7) REPORT OF THE FEDERAL MINISTRY FOR EDUCATION AND SCIENCE ON REQUIRED RESEARCH PROJECTS IN THE FIELD OF REACTOR SAFETY, JULY 1-SEPTEMBER 30, 1971. (Technischer Ueberwachungs-Verein e. V., Cologne (West Germany). Institut fuer Reaktorsicherheit). Mar 1972. 108p. (In German). Dep. NTIS (U. S. Sales Only).

Brief descriptions of research projects on the safety aspects of water cooled reactors in the Federal Republic of Germany are presented. (D.C.C.)

35457 (UCLA-34-P-193-10) SIMULATING STRONG MOTION EARTHQUAKE EFFECTS ON NUCLEAR POWER PLANTS USING EXPLOSIVE BLASTS. Chrostowski, J.; Duke, C. M.; Hart, Gary C.; Howard, G.; Ibanez, P.; DiJulio, R.; Kharraz, Y.; Matthiesen, R. B.; Smith, C. B. (California Univ., Los Angeles. Nuclear Energy Lab.). Feb 1972. Contract AT(04-3)-34. 229p. (UCLA-ENG-7119). Dep. NTIS.

Tests using high explosives to simulate the ground motion produced by earthquakes are described. The tests were conducted at the Experimental Gas-Cooled Reactor (EGCR) facility at Oak Ridge National Laboratory. The objectives of the tests were to determine the feasibility of dynamic response measurements using blast-induced vibrations and to determine the nonlinear response of structures due to high force levels typical of moderate to strong motion earthquakes. The test results are described and compared to results obtained by using structural vibrators. (H.D.R.)

35458 (WASH-1509) LIQUID METAL FAST BREEDER REACTOR DEMONSTRATION PLANT. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Apr 1972. 419p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the proposed Liquid Metal Fast Breeder Reactor Demonstration Plant is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for reactor operation is included. (D.C.C.)

35459 EXPLOSIVE DISASSEMBLY OF FAST REACTORS. Lee, John C.; Pigford, Thomas H. (Univ. of California, Berkeley). Nucl. Sci. Eng.; 48: No. 1, 28-44(May 1972).

Theoretical analysis of the explosive disassembly of fast reactors, following accidental loss of coolant and melting and gravity compaction of the fuel material, was undertaken. A general expression for the rate of reactivity feedback due to material disassembly in a core with more than one enrichment zone was derived. Energy release in cylindrical geometry was calculated with the effects due to zonal interfaces properly considered in the limit of zero acoustic speeds. The effect on the energy release of the assumption of fixed fuel density in the fuel equation-of-state was investigated for oxide-fueled zoned cores. Fuel zoning can result in either greater or less energy release, as compared with a homogeneous core of the same fuel inventory and the same initial conditions, depending on the gradient of the density worth function at the zonal interface. In some large fast breeder reactors the gradient of the density worth function may be negative at the zonal interface. The positive pressure gradient at the interface during the disassembly phase of a transient results in inwardly directed fuel displacement at the interface and in a positive contribution to the disassembly reactivity feedback. Typically, this can increase the energy released in a disassembly transient by as much as 35%. The effect on energy release of the assumption of fixed fuel density in the fuel equation-of-state was not significant for the transients initiated in the completely molten sodium-free reactor cores studied. (31 references) (auth)

35460 THEORETICAL ASPECTS OF THE FIELD RADIOLOGICAL MONITORING SYSTEM FOR A REACTOR ACCIDENT. I. FUNDAMENTAL DESCRIPTIONS. Kadokawa, Masayoshi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 4, 203-12(Apr 1972).

Fundamental principles for designing the ideal field monitoring network have been studied from the viewpoint of monitor detecting capability. The detecting capability is specified by a radius of orbicular "detecting domain" such that the radioactive cloud flowing into the domain gives an exposure-rate above the alarm level to the detector; for example, 100 m for a cloud-gamma detector at 2 km downwind, 400 m for a cloud-concentration monitor at 1 km downwind, assuming a radioactive cloud that inflicts a dose of 100 rems to the thyroid of a child staying for 10 hr at the point of maximum concentration. The ideal distribution of detectors are obtained by adjoining their detecting domains so as to surround the reactors, keeping an outlying distance from the reactors, i.e., 1.8 km, to retain complete capability for detecting a radioactive cloud, and to eliminate the direct gamma radiation assuming the 10^6 Ci of fission products confined in the reactor in an accident. In the neighborhood of reactors, film-dosimeters or TLD are advisable instead of the γ-monitors. The concept of detecting domain is also applicable to the evaluation of the probability of detecting a radioactive cloud by a deficient monitoring network, composed of insufficient number of field monitors. (24 references) (auth)

35461 AFTERHEAT OF A HIGH-TEMPERATURE REACTOR AS DRIVING ENERGY FOR AN EMERGENCY COOLING SYSTEM. Bammert, K.; Krontiris, E. (Technische Univ., Hanover). Atomkernenergie; 19: No. 3, 233-6(May 1972). (In German).

Investigations have shown that a HTR reactor may be cooled sufficiently by means of an emergency cooling system containing a gas turbine and a compressor within the closed cycle. The system uses the afterheat of the shut-down reactor. In this way melting of the core and emission of uncontrollable amounts of radioactive substances is prevented even in the case of a possible accident. The emergency cooling system with gas turbine developed on the basis of the safety requirements of a ship reactor may be used for other nuclear power plants too. Emergency cooling of these reactors is not only a question of safety but also of economy. (auth)

Steam and Power Conversion System

35462 IMPROVEMENTS TO VAPOR GENERATORS. (to Babcock-Atlantique). French Patent 2,074,732. 8 Oct 1971. Filed 22 Jan 1970. (In French).

Steam generator heat exchangers utilizing liquid metal (e.g. Na) as the heating fluid and a nuclear reactor as the energy source are described. The steam generator developed consists of an enclosure receiving the heating fluid. This enclosure is vertically traversed by a bundle of tubes which follow a continually ascending path. The tubes are connected at their lower ends by at least one water-box type tubular plate situated within the enclosure but out of contact with the heating fluid. (France)

35463 STEAM GENERATORS FOR SODIUM-COOLED FAST REACTORS. Krizek, Vladimir; Dubsek, Frantisek. Jad. Energ.; 18: No. 2, 40-4(Feb 1972). (In Czech).

A Czech micromodular type of steam generator with a tube bundle in a U-shaped form and an emergency system is described. Tests in Soviet-designed sodium installations are reviewed. The new generator offers reliability in its use at larger power plants. (6 references) (tr-auth)

Commercial Power Reactors

35464 SELECTED MATERIALS ON THE CALVERT CLIFFS DECISION, ITS ORIGIN AND AFTERMATH. JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY SECOND CONGRESS, FIRST SESSION, FEBRUARY 1972. Washington, D. C.; Joint Committee on Atomic Energy (1972). 681p. GPO $2.75.

35465 NUCLEAR POWER PLANT WUERGASSEN. Goetz, A. Energiewirt. Tagesfragen; 21: No. 10, 591-600(1971). (In German).

An outline is given of location and site plan and of the most important design data of the nuclear power plant. This is followed by short descriptions of the following sections: nuclear steam generator system, main heat circuit and turboset, cooling-water supply, nuclear auxiliary system, safety systems, emergency cooling systems, waste processing equipment and electrotechnical equipment. Furthermore, a time-table is given of the course of construction. (INIS)

35466 STUDY OF NUCLEAR REACTORS AT 1971 GENEVA CONFERENCE. Grenon, M. Energ. Nucl. (Paris); 13: No. 6, 412-20(Nov-Dec 1971). (In French).

The current situation concerning the different types of reactor used in the world is reviewed: light water reactors; high temperature gas reactors; fast neutron reactors. (France)

35467 PLANNING AND CONSTRUCTION OF THE 1200-MW NUCLEAR POWER PLANT BIBLIS. Fridrich, A. (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen); Duesenberg, H. Konstr. Ing. Ber.; No. 10, 63-78(1971). (In German).

A description is given of the purposes of planning details as well as of the previous history of planning, including above all model tests to control the cooling problems. The construction of buildings and structures is based on the expectable loads which are explained in detail. This is followed by a description of radiation protection and sound insulation and by a presentation of the time schedule for the reactor construction, according to components. The construction progress is described to November 1970. (INIS)

Physics and Core Engineering

Refer also to abstracts 35612, 35620, and 35626.

35468 TWENTY FIVE YEARS OF EXPERIENCE WITH THERMAL AND NUCLEAR EQUIPMENT OF EDF. DEVELOPMENTS IN CIVIL ENGINEERING RELATED TO THERMAL AND NUCLEAR POWER PLANTS DURING 25 YEARS. Bordet, R. (Electricite de France, Paris). Travaux; No. 440, 21(Nov 1971). (In French).

Emphasis is given to the fact that the civil engineering aspects of the nuclear and thermal power plants of the EDF are related to the growth in power delivered by the individual units and thus to the dimensions and weight of the principal materials used, and also to the technical progress accomplished in their conception. (France)

Control and Instrumentation

Refer also to abstract 35616.

Containment Systems, Waste Processing, and Radiation Protection

35469 (GULF-GA-A-10875) FORT ST. VRAIN UNIT 1 PCRV LEAK TEST REPORT FOR PUBLIC SERVICE COMPANY OF COLORADO. Barker, R.; Rath, U. K.; Tammadge, C. E. (Gulf General Atomic Co., San Diego, Calif.). 1 Feb 1972. Contract AT(04-3)-633. 124p. Dep. NTIS.

The purpose of the PCRV leak test was to measure the integrated leakage from the PCRV pressure boundary, and to demonstrate that the leak rate was within allowable limits. The PCRV leak test was conducted for 91 hours during stage IV of the PCRV pressure test. The leak rate was computed by the reference vessel method and by the absolute pressure method. At the 78th hour of the test, a known leakage was superimposed to establish the accuracy and sensitivity of the test instrumentation. Both methods indicated a leak rate of less than 14.4% per year, and the accuracy and sensitivity of the instrument were shown to be well within acceptable levels. (4 references) (auth)

35470 PECULIARITIES IN THE CONSTRUCTION OF THE DEPRESSION SYSTEM FOR THE WUERGASSEN NUCLEAR POWER STATION. Boddenberg, K.; Mueller, S. Schweissen Schneiden; 23: No. 9, 353-6(1971). (In German).

Some of the problems involving manufacturing techniques that were met with during the construction of the containment vessel for the Wuergassen Reactor are discussed. In particular a description is given of the connection of the vessel base plate and its compression struts of the spherical shell by means of so-called "K" sections, the fabrication of the reinforcing ring for connecting the base section to the spherical shell and the welding in of support brackets and strengtheners. During the construction of the containment vessel special attention was given to the exact planning of the work involved and to finding an early solution to all of the problems that could arise during the process of fabrication. (INIS)

35471 TWENTY FIVE YEARS OF EXPERIENCE WITH THERMAL AND NUCLEAR EQUIPMENT OF EDF. DEVELOPMENT OF REACTOR VESSELS IN GAS-GRAPHITE NATURAL URANIUM REACTORS. Valette, J. (Electricite de France, Tours). Travaux; No. 440, 45-6(Nov 1971). (In French).

During the development of French reactors, the sealed enclosure surrounding the reactor and containing CO_2 had to be built to withstand increasing pressures. The vessels of Chinon 1 and Chinon 2 are constructed of steel; in spite of the fact that the vessels of Chinon 3 and Chinon 2 are similar, prestressed concrete was adopted for the construction of Chinon 3. This solution was reached as a result of experience acquired with the prestressed concrete vessels of G2 and G3, already in use. The integrated systems (exchangers and blowers inside the vessel) used for the Saint-Laurent 1, Saint-Laurent 2, and Bugey 1 reactors for which prestressed concrete vessels are the only solution were developed in accordance with these ideas. (France)

35472 INSULATOR-TYPE HIGH-PRESSURE CABLE PENETRATION OF REACTOR CONTAINERS. Futamura, Yoshiaki; Watanabe, Masaaki (Japan Atomic Energy Research Inst., Tokai). Karyoku Hatsuden; 22: No. 8, 906-12(Aug 1971). (In Japanese).

To supply electricity and to transmit and receive control signals for various devices installed in reactor containers, cable penetrations are provided in the reactor containers. Because this penetration constitutes a part of the reactor containers, air-tightness of the penetration must be maintained. Problems with insulation of the cable penetration cannot be ignored, because the cable penetration is sometimes subject to spatial restriction and is compelled to be installed in circumstances of high humidity. Details are presented of the cable penetration for a high pressure container, which was developed for JPDR-II, and which is composed of an insulator as insulating material, of a silicone rubber gasket as seal between an insulator and a plate to install a cable and of a teflon bush as seal between an insulator and a conductor. Various experiments carried out to investigate the cable penetration are described. The strength of connection between the insulator and metal fittings was tested, assuming earthquake stresses, serious accidents and artificial loading, and the safety was verified. Thermal shock tests were performed with and without load, and the safety was proven. Air-tight test, leakage test and insulating test were also performed. (Japan)

35473 SAFETY CONTAINMENTS FOR THE SWISS ATOMIC POWER PLANTS BEZNAU I, BEZNAU II, AND MUEHLEBERG. Hesse, M. Schweissen Schneiden; 23: No. 9, 359-63(1971). (In German).

As a result of the ever increasing demand for electricity, Switzerland has been compelled to erect atomic power plants. For safety reasons, the primary units of these power plants have to be enclosed by steel containments. The organization, the assembly welding, and testing methods devised for the safety containments built in Switzerland are discussed. (INIS)

Coolant System

Refer also to abstracts 33123, 33530, 35610, 35613, 35621, and 35623.

Fuels and Fuel Elements

Refer also to abstract 35614.

35474 ANALYSIS ON COMPETITIVENESS OF NUCLEAR POWER GENERATION WITH THERMAL POWER GENERATION AFTER HIKE IN PRICE OF CRUDE PETROLEUM. Suzuki, Shinji; Shimizu, Shunsaku (Japan Energy Economic Research Inst., Tokyo). FAPIG (Tokyo); No. 62, 52-7(Aug 1971). (In Japanese).

A possible hike in the price of crude petroleum in the near future is discussed. Predictions made for the expansion of nuclear and petroleum power sources are revised. Economic factors concerning nuclear and petroleum power sources are compared. (Japan)

Operation and Economics

Refer also to abstracts 35609, 35615, 35618, 35619, 35625, and 35627.

35475 (DLCS–5000471) SHIPPINGPORT ATOMIC POWER STATION. Quarterly Operating Report, Fourth Quarter 1971. (Duquesne Light Co., Shippingport, Pa.). 1971. Contract AT-11-1-292. 19p. Dep. NTIS.

Operations and maintenance requirements during October to December 1971 are described. Water chemistry conditions during the quarter are analyzed. (D.C.C.)

35476 (DOCKET-1155–168) LA CROSSE BOILING WATER REACTOR. Reactor Partial Scram Due to Exercising the Turbine Stop Valve Without Scram Interlock Bypassed. (Dairyland Power Cooperative, La Crosse, Wis.). 5 May 1972. 3p. Dep. NTIS.

35477 (DOCKET-1155–169) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, March 1972. (Dairyland Power Cooperative, La Crosse, Wis.). 31 Mar 1972. Contract AT(11-1)-851. 26p. (DPC–851-41). Dep. NTIS.

35478 (DOCKET-50016–157) ENRICO FERMI ATOMIC POWER PLANT. Calibration of Monitor of Main Condenser Cooling Water Discharge Delayed. (Power Reactor Devlopment Co., Detroit, Mich.). 22 May 1972. 1p. Dep. NTIS.

35479 (DOCKET-50219–184) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Results of Inspections of Safety Valves. (General Electric Co., San Jose, Calif. Nuclear Energy Div.). 10 May 1972. 4p. Dep. NTIS.

35480 (DOCKET-50219–185) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Facility Change Request 3 Allowed. (Directorate of Licensing (AEC), Washington, D. C.). 18 May 1972. 1p. Dep. NTIS.

Authorization for the use of Type 3 fuel bundles in the cycle 2 reload configuration for the reactor is presented. (D.C.C.)

35481 (DOCKET-50237–233) DRESDEN NUCLEAR POWER STATION, UNIT 2. Greater Than 0.7 Curies of Radioactivity in Waste Surge, May 17, 1972. (Commonwealth Edison Co., Chicago, Ill.). 18 May 1972. 1p. Dep. NTIS.

35482 (DOCKET-50237–235) DRESDEN NUCLEAR POWER STATION, UNIT 2. Five Areas of Leakage in Excess of Limits Identified. (Commonwealth Edison Co., Chicago, Ill.). 18 May 1972. 4p. Dep. NTIS.

Excessive leaks are described for the primary containment personnel air lock, the pressure suppression system air operated butterfly valves, and feedwater check valves. (D.C.C.)

35483 (DOCKET-50244–100) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Residual Heat Removal System Loss of Function. (Rochester Gas and Electric Corp., N. Y.). 15 May 1972. 3p. Dep. NTIS.

35484 (DOCKET-50245–129) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Primary Coolant Leakage to Drywell. (Millstone Point Co., Hartford, Conn.). 8 May 1972. 9p. Dep. NTIS.

35485 (DOCKET-50249–133) DRESDEN NUCLEAR POWER STATION, UNIT 3. Isolation Condenser Valve 3-1301-3 Failed to Open Following a Reactor Scram. (Division of Reactor Licensing (AEC), Washington, D. C.). 8 May 1972. 2p. Dep. NTIS.

35486 (DOCKET-50254–90) QUAD-CITIES STATION, UNITS 1 AND 2. Multiple Failures Due to an Operating Error. (Commonwealth Edison Co., Cordova, Ill.). 4 May 1972. 5p. (DOCKET-50265–73). Dep. NTIS.

A description of incorrect inspection procedures which resulted in damage to the excitation section of the Unit 2 emergency diesel generator is presented. Corrective actions are described. (D.C.C.)

35487 (DOCKET-50255–83) PALISADES PLANT. Discovery of a Shoulder Bolt in No. 2 Steam Generator. (Consumers Power Co., Jackson, Mich.). 16 May 1972. 8p. Dep. NTIS.

35488 (DOCKET-50255–84) PALISADES PLANT. Special Report 3, Sixty-Percent Power Escalation Testing. (Consumers Power Co., Jackson, Mich.). 18 May 1972. 14p. Dep. NTIS.

35489 (DOCKET-50261–91) H. B. ROBINSON UNIT 2. B Residual Heat Exchanger Leakage. (Carolina Power and Light Co., Raleigh, N. C.). 16 May 1972. 1p. Dep. NTIS.

35490 (DOCKET-50265–75) QUAD-CITIES STATION, UNIT 2. Turning Gear Motor Failed on High Pressure Coolant Injection System. (Commonwealth Edison Co., Cordova, Ill.). 18 May 1972. 1p. Dep. NTIS.

35491 (DOCKET-50265–77) QUAD-CITIES STATION, UNIT 2. Low Water Level Scram on May 24, 1972. (Directorate of Licensing (AEC), Washington, D. C.). 24 May 1972. 1p. Dep. NTIS.

35492 (ORNL-NSIC–103) ABNORMAL REACTOR OPERATING EXPERIENCES, 1969–1971. (Oak Ridge National Lab., Tenn.). May 1972. Contract W-7405-eng-26. 201p. Dep. NTIS.

Reports describing abnormal reactor operating experiences during 1969 to 1971 are presented. The reports are arranged in numerical order and consequently are listed in chronological order. An index is prepared using keywords from the NSIC thesaurus of indexing terms. A permitted title index is also included. (D.C.C.)

35493 NUCLEAR POWER PLANTS IN THE WORLD. Fiorentini, Paola. Com. Naz. Energ. Nucl., Notiz.; 18: No. 3, 30-51(Mar 1972). (In Italian).

A review is presented of the nuclear power plants in operation, under construction or planned in the world as of February 1972. After a brief introduction concerning the present situation, a listing by countries is given of the nuclear power plants with the respective technical, economic and operating data. (auth)

Safety and Siting

Refer also to abstracts 35611 and 35617.

35494 (DOCKET-50029–181) YANKEE NUCLEAR POWER STATION. Technical Specifications, Proposed Change 100, Selected Control Rod Drop Time History. (Yankee Atomic Electric Co., Westboro, Mass.). 18 May 1972. 3p. Dep. NTIS.

35495 (DOCKET-50133–85) HUMBOLDT BAY POWER PLANT, UNIT 3. Technical Specifications, Proposed Change 39. (Pacific Gas and Electric Co., San Francisco, Calif.). 19 May 1972. 11p. Dep. NTIS.

Revised technical specifications are presented concerning testing schedules for engineered safeguards. (D.C.C.)

35496 (DOCKET-50155–112) BIG ROCK POINT NUCLEAR PLANT. Design Basis Accident Loss-of-Cooling Analysis for NFS Demonstration Fuel Assemblies. (Consumers Power Co., Jackson, Mich.). 18 May 1972. 18p. Dep. NTIS.

35497 (DOCKET-50206–153) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Responses to AEC Items Concerning Analysis of Emergency Core Cooling System Performance. (Southern California Edison Co., Rosemead, Calif.). 12 May 1972. 31p. Dep. NTIS.

35498 (DOCKET-50206–154) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Turbine Overspeed. (Southern California Edison Co., Rosemead, Calif.). 9 May 1972. 2p. Dep. NTIS.

35499 (DOCKET-50213–139) HADDAM NECK PLANT, UNIT 1. Emergency Core Cooling System Report, Additional Information. (Connecticut Yankee Atomic Power Co., Hartford). 19 May 1972. 39p. Dep. NTIS.

35500 (DOCKET-50219–186) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Technical Specifications, Change Request 11. (Jersey Central Power and Light Co., Morristown, N. J.). 17 May 1972. 4p. Dep. NTIS.

Revised technical specifications are presented concerning modified operating requirements for the containment spray system. The modifications will prevent personnel from being exposed to the toxic chromated water of the spray system. (D.C.C.)

35501 (DOCKET-50220–93) NINE MILE POINT NUCLEAR STATION, UNIT 1. Results of the Inspection of Pressure Suppression Torus. (Niagara Mohawk Power Co., Syracuse, N. Y.). 10 May 1972. 15p. Dep. NTIS.

35502 (DOCKET-50220–94) NINE MILE POINT NUCLEAR STATION, UNIT 1. Torus Baffle Modification Acceptable. (Directorate of Licensing (AEC), Washington, D. C.). 16 May 1972. 2p. Dep. NTIS.

35503 (DOCKET-50237–230) DRESDEN NUCLEAR POWER STATION, UNIT 2. Special Report No. 17, Torus Coating Inspection. (Commonwealth Edison Co., Chicago, Ill.). 9 May 1972. 5p. Dep. NTIS.

35504 (DOCKET-50237-231) DRESDEN NUCLEAR POWER STATION, UNIT 2. Additional Information Relating to Peeco Flow Switches. (Commonwealth Edison Co., Chicago, Ill.). 12 May 1972. 4p. Dep. NTIS.

35505 (DOCKET-50237-232) DRESDEN NUCLEAR POWER STATION, UNIT 2. Technical Specifications, Change 14. (Directorate of Licensing (AEC), Washington, D. C.). 16 May 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning the scram trip setting for the average power range monitor during startup transient tests. (D.C.C.)

35506 (DOCKET-50237-234) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Revised Generating Stations Emergency Plan, Replaces 50237-27 and 50249-27. (Commonwealth Edison Co., Chicago, Ill.). 12 May 1972. 152p. (DOCKET-50249-134). Dep. NTIS.

35507 (DOCKET-50244-99) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Technical Specifications, Change 1, Additional Information. (Rochester Gas and Electric Corp., N. Y.). 15 May 1972. 5p. Dep. NTIS.

Additional information is presented concerning revised control rod insertion limits. (D.C.C.)

35508 (DOCKET-50245-130) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Technical Specifications, Proposed Change 4. (Millstone Point Co., Hartford, Conn.). 20 May 1972. 12p. Dep. NTIS.

Revised technical specifications are presented concerning the use of respiratory protective equipment by personnel. (D.C.C.)

35509 (DOCKET-50254-89) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Proposed Change. (Commonwealth Edison Co., Chicago, Ill.). 9 May 1972. 10p. (DOCKET-50265-72). Dep. NTIS.

Revised technical specifications are presented concerning the use of respiratory protective equipment for personnel. (D.C.C.)

35510 (DOCKET-50254-91) QUAD-CITIES STATION, UNITS 1 AND 2. Facility Operating License DPR-29, Amendment 3 (Unit 1); Facility Operating License DPR-30, Amendment 1 (Unit 2). (Directorate of Licensing (AEC), Washington, D. C.). 12 May 1972. 56p. (DOCKET-50265-74). Dep. NTIS.

Authorization for operating the reactors at 90 percent of rated power is presented. Technical specifications concerning chemical and thermal discharges from the reactors are included. (D.C.C.)

35511 (DOCKET-50254-92) QUAD-CITIES STATION, UNITS 1 AND 2. Environmental Report, Supplement 6. (Commonwealth Edison Co., Chicago, Ill.). 17 May 1972. 4p. (DOCKET-50265-76). Dep. NTIS.

Present and predicted population distribution charts for the area adjacent to the reactor site are presented. (D.C.C.)

35512 (DOCKET-50259-49) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 29. (Tennessee Valley Authority, Chattanooga). 17 May 1972. 19p. (DOCKET-50260-46; DOCKET-50296-43). Dep. NTIS.

Revised and additional data are presented concerning cost estimates, emergency core cooling system, personnel organization charts, and personnel qualifications. (D.C.C.)

35513 (DOCKET-50259-50) BROWNS FERRY NUCLEAR STATION, UNITS 1, 2, AND 3. Decision to Install Mechanical Draft Cooling Towers for Auxiliary Cooling. (Tennessee Valley Authority, Chattanooga). 16 May 1972. 2p. (DOCKET-50260-47; DOCKET-50296-44). Dep. NTIS.

35514 (DOCKET-50263-121) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Environmental Report, Errata Sheets. (Northern States Power Co., Minneapolis, Minn.). 2 May 1972. 25p. Dep. NTIS.

Corrected information is presented concerning meteorological data for the reactor site, radioactive discharges from the reactor, and site biota. (D.C.C.)

35515 (DOCKET-50266-67) POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). May 1972. 188p. (DOCKET-50301-56). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactors is presented. The effects of reactor operations on the environment are analyzed. Cost-benefit analysis for the reactors is included. (D.C.C.)

35516 (DOCKET-50272-28) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Supplemental Environmental Report, Amendment 1. (Public Service Electric and Gas Co., Newark, N. J.). 19 May 1972. 258p. (DOCKET-50311-28). Dep. NTIS.

Additional information is presented concerning thermal discharges from the reactors, site biota, and cost-benefit analysis of reactor operations. (D.C.C.)

35517 (DOCKET-50282-54) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 17. (Northern States Power Co., Minneapolis, Minn.). 19 May 1972. 279p. (DOCKET-50306-52). Dep. NTIS.

Revised design parameters of the Prairie Island Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

35518 (DOCKET-50293-71) PILGRIM NUCLEAR POWER STATION. Torus Loading Evaluation. (Boston Edison Co., Mass.). 8 May 1972. 4p. Dep. NTIS.

35519 (DOCKET-50293-72) PILGRIM NUCLEAR POWER STATION. Final Safety Analysis Report, Amendment 33. (Boston Edison Co., Mass.). 19 May 1972. 6p. Dep. NTIS.

Corrected information is presented concerning the personnel organization structure and turbine control valve fast closure. (D.C.C.)

35520 (DOCKET-50295-49) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Volume 9, Amendment 20. (Commonwealth Edison Co., Chicago, Ill.). 15 May 1972. 526p. (DOCKET-50304-49). Dep. NTIS.

Revised design parameters of the Zion Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. Revised technical specifications are also presented. (D.C.C.)

35521 (DOCKET-50295-50) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 21. (Commonwealth Edison Co., Chicago, Ill.). 19 May 1972. 87p. (DOCKET-50304-50). Dep. NTIS.

Requested information on the quality assurance program is presented. (D.C.C.)

35522 (DOCKET-50295-51) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Environmental Report, Supplement 5. (Commonwealth Ediwon Co., Chicago, Ill.). 18 May 1972. 167p. (DOCKET-50304-51). Dep. NTIS.

Environmental temperature survey for Lake Michigan near Zion Power Reactor Units 1 and 2 during July to December 1969 is presented. (D.C.C.)

35523 (DOCKET-50298-32) COOPER NUCLEAR STATION. Combustible Gas Control. (Nebraska Public Power District, Columbus). 15 May 1972. 6p. Dep. NTIS.

35524 (DOCKET-50298-33) COOPER NUCLEAR STATION. Quality Control Requirements Associated With Electrical Power Installation. (Division of Compliance, Denver, Colo. Region IV). 16 Aug 1971. 8p. Dep. NTIS.

35525 (DOCKET-50298-34) COOPER NUCLEAR STATION. Steps Taken to Correct an Item of Apparent Noncompliance Noted in Letter of November 1, 1971. (Division of Compliance, Denver, Colo. Region IV). 7 Dec 1971. 3p. Dep. NTIS.

Additional information is presented concerning minimum wall thickness verification of cast body valves for pressure vessel piping. (D.C.C.)

35526 (DOCKET-50298-35) COOPER NUCLEAR STATION. Final Safety Analysis Report, Amendment 11. (Nebraska Public Power District, Columbus). 30 May 1972. 162p. Dep. NTIS.

Requested additional information is presented concerning design parameters and operations aspects of the Cooper Power Reactor. (D.C.C.)

35527 (DOCKET-50301-57) POINT BEACH NUCLEAR PLANT, UNIT 2. Objection to Test Shut Down of Reactor From Outside of Control Room. (Wisconsin Electric Power Co., Milwaukee). 18 May 1972. 3p. Dep. NTIS.

35528 (DOCKET-50302-43) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Specifications for Proof Testing of Chemically Consolidated Foundation Elements. (Gilbert Associates, Inc., Reading, Pa.). 7 Jan 1970. 26p. Dep. NTIS.

For Florida Power Corp., St. Petersburg.

35529 (DOCKET-50302–44) CRYSTAL RIVER NUCLEAR PLANT, UNIT 3. Specifications for Subsurface Grouting. (Gilbert Associates, Inc., Reading, Pa.). 12 Aug 1970. 39p. Dep. NTIS.

For Florida Power Corp., St. Petersburg.

35530 (DOCKET-50302–45) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Environmental Report, Supplement 1. (Florida Power Corp., St. Petersburg). 9 May 1972. 252p. Dep. NTIS.

Requested additional information is presented concerning chemical and thermal discharges from the reactor, site biota, and cost-benefit analysis for reactor operation. (D.C.C.)

35531 (DOCKET-50305–40) KEWAUNEE NUCLEAR POWER PLANT. Final Safety Analysis Report, Amendment 18. (Wisconsin Public Service Corp., Green Bay). 19 May 1972. 237p. Dep. NTIS.

Revised design parameters of the Kewaunee Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

35532 (DOCKET-50312–38) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report, Amendment 10. (Sacramento Municipal Utility District, Calif.). 15 May 1972. 295p. Dep. NTIS.

Revised design parameters of the Rancho Seco Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

35533 (DOCKET-50315–63) DONALD C. COOK NUCLEAR POWER PLANT, UNITS 1 AND 2. SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. McGUIRE NUCLEAR STATION, UNITS 1 AND 2. MPR-340, Ice Condenser Containment Independent Analysis Program, Final Report. (MPR Associates, Inc., Washington, D. C. (USA)). Apr 1972. 155p. (DOCKET-50316–63; DOCKET-50327–24; DOCKET-50328–23; DOCKET-50390–14; DOCKET-50391–14; DOCKET-50369–24; DOCKET-50370–24). Dep. NTIS.

35534 (DOCKET-50324–37) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Evaluation of Effects of All Blowdown Forces Into the Tori. (Carolina Power and Light Co., Raleigh, N. C.). 17 May 1972. 17p. (DOCKET-50325–38). Dep. NTIS.

35535 (DOCKET-50331–34) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report Meteorological Data. (Iowa Electric Light and Power Co., Cedar Rapids). 1971. 283p. Dep. NTIS.

35536 (DOCKET-50333–43) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement 7. (Power Authority of the State of New York). 18 May 1972. 187p. Dep. NTIS.

Revised design parameters of the James A. Fitzpatrick Power Reactor are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

35537 (DOCKET-50333–44) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Supplement to Letters of April 12 and 25, Tabulation of Valves Within the Reactor Coolant Pressure Boundary. (Power Authority of the State of New York). 19 May 1972. 4p. Dep. NTIS.

35538 (DOCKET-50358–36) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). May 1972. 134p. Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Site biota is described. Hydrological, geological, and meteorological data for the reactor site are presented. Cost-benefit analysis for reactor operation is included. (D.C.C.)

35539 (DOCKET-50358–37) WILLIAM H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Safety Evaluation, Errata Sheet. (Directorate of Licensing (AEC), Washington, D. C.). 22 May 1972. 12p. Dep. NTIS.

35540 (DOCKET-50361–23) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Volume VI, Amendment 13. (Southern California Edison Co., Rosemead, Calif.). 15 May 1972. 431p. (DOCKET-50362–22). Dep. NTIS.

Revised design parameters of the San Onofre Power Reactor Units 2 and 3 are presented. Included also are additional data on the reactors requested by the Division of Reactor Licensing. (D.C.C.)

35541 (DOCKET-50361–24) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Methods of Direct Application of Element Damping. (Bechtel Corp., San Francisco, Calif.). Jan 1972. 47p. (DOCKET-50362–23). Dep. NTIS.

For Southern California Edison Co., Los Angeles.

The methods used in applying damping in the analysis of seismic Class I structures are presented. The formulation of a comprehensive nonproportional damping matrix for use in the solution of the equations of motion is described. The term nonproportional damping is defined, a direct comparison between this method and the usual method of application of proportional damping in the dynamic time-history analysis of structures is presented. Two separate analyses using the concept of nonproportional damping have been performed and are included. (auth)

35542 (DOCKET-50363–25) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 1, Revised Figures. (Jersey Central Power and Light Co., Morristown, N. J.). 15 Jul 1970. 7p. Dep. NTIS.

Additional diagrams are presented concerning the arrangement of buildings and components. An organizational chart is presented for management. (D.C.C.)

35543 (DOCKET-50369–23) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Environmental Report, Supplement 3. (Duke Power Co., Charlotte, N. C.). 22 May 1972. 35p. (DOCKET-50370–23). Dep. NTIS.

Information concerning thermal discharges from the reactors is presented. Cost-benefit analysis for reactor operation is included. (D.C.C.)

35544 (DOCKET-50376–33) AGUIRRE NUCLEAR PLANT, UNIT 1. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). May 1972. 148p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Biota for the reactor site is described. Cost-benefit analysis for reactor operations is included. (D.C.C.)

35545 (DOCKET-50390–15) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 7. (Tennessee Valley Authority, Chattanooga). 17 May 1972. 93p. (DOCKET-50391–15). Dep. NTIS.

Revised and additional data on the design parameters and operations aspects of the reactors are presented. Revised information concerning the quality assurance program is included. (D.C.C.)

35546 (LIB/Trans–419) CONSIDERATION OF PROPOSED INSTALLATIONS FROM THE POINT OF VIEW OF RADIOLOGICAL SAFETY. Duverger de Cuy, G.; Guirlet, J.; Japavaire, R.; Lucas, G.; de Montaignac, E.; de Kerdelleau, J. Lemenz; Porcheron, J.; Rousseau, L.; Salle, R.; Slizewicz, P. Translated by J. P. Ikenberg for Australian Atomic Energy Commission, from Bull. Inform. Sci. Tech. (Paris); No. 158, 21–33(Apr 1971). 16p. Dep. NTIS (U. S. Sales Only).

Typical accidents and their consequences are studied first, after which the working conditions in the plant are defined and different "zones" established as a function of the irradiation or contamination hazards they present. Radiological safety also depends on the confinement and ventilation conditions in the premises; normal running conditions are checked by the suitable placing of measurement or alarm instruments and special attention is paid to systems for the handling of strongly radioactive materials (spent fuel assemblies for example), these being infrequent operations involving special risks. Finally the problems raised by radioactive wastes, whether gaseous, liquid or solid, must not be neglected. (auth)

35547 (TID–26006) DESIGN OF THE MONITORING SYSTEM FOR THE THERMAL EFFECT STUDY OF THE SURRY NUCLEAR POWER PLANT ON THE JAMES RIVER. Special Report in Applied Marine Science and Ocean Engineering, Number 16. Bolus, R. L.; Chia, S. N.; Fang, C. S. (Virginia Inst. of Marine Science, Gloucester Point). Oct 1971. Contract AT(40-1)-4067. 75p. Dep. NTIS.

The program for monitoring thermal discharges from the Surry Power Reactor Units 1 and 2 to the James River is reviewed.

Instrumentation used for the monitoring program is described. Recorded data are included. (D.C.C.)

35548 (WASH–1516) ELK RIVER REACTOR DISMANTLING, ELK RIVER, MINNESOTA. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). May 1972. 123p. Dep. NTIS.

The impact on the environment of dismantling the Elk River Power Reactor is analyzed. (D.C.C.)

35549 H.R. 13731 AND H.R. 13732, TO AMEND THE ATOMIC ENERGY ACT OF 1954 REGARDING THE LICENSING OF NUCLEAR FACILITIES. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, SECOND SESSION, MARCH 16 AND 17, 1972, PART 2, SUPPLEMENTAL MATERIALS. Washington, D. C.; Joint Committee on Atomic Energy (1972). 586p. GPO $2.50.

Testimony, statements by interested parties, and related information submitted to supplement the hearings on proposed legislation to amend the Atomic Energy Act of 1954 are presented. The proposed amendments would require construction permits for facilities prior to construction commencement and would allow temporary operating authorizations for nuclear power plants. (H.D.R.)

35550 PRESENT, NEW, AND FUTURE LAW CONCERNING THIRD PARTY LIABILITY FOR NUCLEAR PLANTS. Fischerhof, H. Energiewirt. Tagesfragen; 21: No. 6, 306-8(1971). (In German).

Those parts of the provisions regulating the liability for nuclear damages within the German Atomic Energy Act are summarized. The amendments were made with a view to and in accordance with the Paris convention on nuclear liability which, however, has not yet been ratified by the FRG. (INIS)

35551 AMENDING THE ATOMIC ENERGY ACT OF 1954, AS AMENDED, TO ADD NEW SECTION 192 TO AUTHORIZE THE ATOMIC ENERGY COMMISSION TO ISSUE TEMPORARY OPERATING LICENSES FOR NUCLEAR POWER REACTORS. REPORT BY THE JOINT COMMITTEE ON ATOMIC ENERGY, NINETY-SECOND CONGRESS, SECOND SESSION, TOGETHER WITH SUPPLEMENTAL VIEWS, MAY 9, 1972. Report No. 92-787. Washington, D. C.; Joint Committee on Atomic Energy (1972). 48p.

35552 KERNKRAFT HEUTE UND MORGEN. KERNFORSCHUNG UND KERNTECHNIK ALS CHANCE UNSERER ZEIT. (Nuclear Power Today and Tomorrow. A Chance Held Out to Us). Gerwin, R. Stuttgart; Deutsche Verlags-Anstalt (1971). 135p.

The most important aspects of the peaceful uses of nuclear energy are discussed. The main subjects are: principles of power generation, characteristics of the various reactor types, most important reactor projects, the fusion reactor, the breeder reactor, direct energy conversion, role of the fuel cycle, risks brought about by nuclear power stations versus environmental protection, nuclear technologies apart from current generation, future power generation. The appendix gives a short survey of organizations and the mode of cooperation within the nuclear field. (INIS)

35553 ASPECTS OF FOUNDATIONS FOR NUCLEAR POWER PLANTS. Breth, H. (Technische Univ., Darmstadt, Ger.). Konstr. Ing. Ber.; No. 10, 94-9(1971). (In German).

The investigation is concerned with the behavior of foundation soils in order to be able to calculate settlement at an early stage. The nuclear power plants Grosswelzheim, Gundremmingen and Biblis are taken as examples for the discussion of settlement and angular deviation (size and direction), as established by measurements. (INIS)

Steam and Power Conversion System

Refer also to abstract 35622.

35554 (DOCKET-50206–155) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Unit Trip and Subsequent Activation of Safety Injection Equipment. (Southern California Edison Co., Rosemead, Calif.). 9 May 1972. 4p. Dep. NTIS.

An unscheduled turbine-reactor trip is described as a result of a malfunctioning positioner on the main feedwater regulating valve for the C steam generator. (D.C.C.)

Propulsion and Auxiliary Power Reactors

Refer also to abstract 33265.

35555 (FXM–4423) STUDY OF LOW POWER REACTORS FOR SPACE APPLICATION WITH UO_2 FUEL ELEMENTS. Levengood, J. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 5 Feb 1960. 14p. Dep. NTIS.

Declassified 28 Oct 1971.

A study of a series of low power reactors of 3 to 30 MW using unmoderated UO_2 fuel pins with columbium cladding is presented. The lithium temperature rise within the core was fixed at 100°F. Previous space vehicle system analysis indicates this to approximate optimum conditions. The reactors are designed to operate at full power for one year. (auth)

35556 (FXM–5232) PERPETUA: A HIGH POWER, TEN MILLION Mw HR, PLUS, FAST BREEDER REACTOR CONCEPT. Johnson, C. W., Jr. (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 10 Apr 1961. 6p. Dep. NTIS.

Declassified 26 Oct 1971.

A reactor concept is examined which, by utilizing an initial critical mass of 400 to 600 kg of ^{235}U in the form of 10% to 20% enriched UC, provides a core breeding ratio of unity, thereby maintaining or for some fuel drum control positions even increasing system reactivity with time. For demonstrative purposes a DSN neutron transport theory study is presented which utilizes a 200 liter core of 500 kg ^{235}U, 20% enriched UC with .25 volume fraction Cb and .25 volume fraction ^{7}Li in the core or enriched UC regions. By assuming use of porous Cb plate cladding it is suggested that fission gas pressure problems are avoided and that UC swelling from irradiation will only reduce coolant passage cross section area and thus cut the initial 1000 MW potential power level to some lower value of power output. Reactor lifetime is predicted to be at least ten million MW hrs. (auth)

35557 (FZM–1250(Rev.A)) SAFETY ANALYSIS FOR NUCLEAR FLIGHT TEST SITES. (Convair, Fort Worth, Tex.). 20 Oct 1958. 74p. Dep. NTIS.

Declassified 1 Nov 1971.

35558 (FZM–2261) SAFETY CRITERIA IN NUCLEAR ROCKET SYSTEMS ANALYSIS. Seale, R. L.; Chura, A. H. (Convair, Fort Worth, Tex.). 18 Apr 1961. 20p. Dep. NTIS.

Declassified 2 Nov 1971.

Safety analysis for the operation of rocket reactors in various flight trajectories is presented. The reactor considered is a 1000 MW heat-exchanger type. The flight trajectories include: ballistic, orbital, and escape. (3 references) (D.C.C.)

35559 (GKSS–71/E/12) N. S. OTTO HAHN. TRIALS REPORT NO. 16, TIME IN SHIPYARD IN HAMBURG (DECEMBER 18, 1970–FEBRUARY 9, 1971) LOADING AND SHAKEDOWN TRIP (VOYAGES NO. 52–57) FROM FEBRUARY 9–JUNE 1, 1971 TO TUNIS–SFAX, SFAX, CASABLANCA AND IN THE NORTH SEA (FILTER TEST JOURNEY). (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 41p. (In German). Dep. NTIS (U. S. Sales Only).

After return from its 51st journey on 16 December 1970, the Otto Hahn was subjected to the routine 7-week annual examination. Subsequently, in the port of Tunis, through a misunderstanding with the tugboat, the ship suffered damage to the rudder. The damage was repaired within three weeks. In addition to the rudder damage, leakages in the main condenser occurred which required tests and repairs. During the journeys, sawdust was added to the cooling water. As a significant improvement, the four-bladed screw was replaced by a six-bladed one. Through this replacement, vibrations in shaft and ship body were markedly reduced. Thus, the ship could be driven at a high rate of speed without disturbances. Tests of the activated charcoal filter showed no decrease in its efficiency, which was 98.8%, far above the required 90%. (H.B.G.)

35560 (LA–2407) CALORIMETER MEASUREMENT OF THE KIWI-A GAMMA RADIATION. Storm, Ellery; Bemis, Edwin (Los Alamos Scientific Lab., N. Mex.). Jan 1960. Contract W-7405-eng-36. 62p. Dep. NTIS.

Declassified 27 Oct 1971.

Three field calorimeters were constructed to measure the gamma rays emitted by the Kiwi-A reactor. The construction, collimation, shielding, and calibration of the calorimeters are described. The results of the measurements of the Kiwi-A gamma rays are presented in terms of absorbed energy rate and dose rate for each power level of reactor operation. The measured gamma ray rates are shown to be closely proportional to the reactor power. (auth)

35561 (LA–2459) SINGLE STAGE NUCLEAR ROCKET STUDY. Haddad, E.; Anderson, W. (Los Alamos Scientific Lab., N. Mex.). Mar 1960. Contract W-7405-eng-36. 77p. Dep. NTIS.

Declassified 26 Oct 1971.

A study is described which was carried out primarily on ground-launched, single-stage, hydrogen-propelled nuclear rockets. The missions considered were flights into circular orbits and ballistic flights. Particular emphasis was given to determine the effect of missile trajectory, for a specified mission, on payload. The types of trajectories considered were the powered-all-the-way (PAW) ascent, the ballistic ascent, and the elliptic ascent. In the PAW missions, the missile was flown from the ground, along a trajectory that maximized payload, into a prescribed circular orbit. The PAW results were then compared, for a particular mission, with ballistic and elliptic ascent calculations. The results show that most of the missions studied were very sensitive to the type of trajectory flown, thus clearly demonstrating the gains to be made by using a nuclear rocket motor which has a recycle capability. Mission performance results have been obtained for various single-stage nuclear systems, but with emphasis on missions which require large payloads in orbit. Technology indicates that a nuclear system having a launch weight of $\sim$400,000 lb would be capable of placing a payload in excess of 40,000 lb into a 300-mi circular orbit. (16 references) (auth)

35562 (LA–2558) RADIOCHEMICAL MEASUREMENTS ON KIWI-A PRIME. Summary Report. Sattizahn, J. E.; Knight, J. D.; Cowan, G. A. (Los Alamos Scientific Lab., N. Mex.). May 1961. Contract W-7405-eng-36. 78p. Dep. NTIS.

Declassified 26 Oct 1971.

The techniques and results of radiochemical measurements on the KIWI-A Prime reactor are presented. Information is given on total fissions produced, power level, fission products released to the atmosphere, fuel-element anomalies, temperature distribution, and neutron fluxes at various points outside the core. (auth)

35563 (LA–4890) PRELIMINARY MISSION STUDIES FOR A SMALL NUCLEAR ENGINE. Balcomb, J. D. (Los Alamos Scientific Lab., N. Mex.). Mar 1972. Contract W-7405-eng-36. 14p. Dep. NTIS.

Preliminary mission studies were made for a small nuclear engine. Single-burn, multiple-burn, and multiple-stage planetary probes, as well as lunar and geosynchronous shuttle vehicles, were considered. Results indicate that a 300-MW engine with a thrust of $\sim$15 000 lbf, an engine mass of 6000 lbm, and a specific impulse of 825 to 875 sec would be very attractive for a wide variety of advanced missions and payloads, including many missions that have previously been considered for the much larger NERVA engine. The small engine is particularly suitable for unmanned missions to the outer planets. (auth)

35564 (ORNL–TM–3270) RELATIVE IMPORTANCE OF NEUTRON CAPTURE AND INELASTIC-SCATTERING INTERACTIONS TO THE SECONDARY GAMMA-RAY DOSE TRANSMITTED THROUGH LAMINATED TUNGSTEN AND LITHIUM HYDRIDE SNAP REACTOR SHIELDS. Pace III, J. V.; Mynatt, F. R.; Abbott, Lorraine S. (Oak Ridge National Lab., Tenn.). 12 Apr 1972. 68p. (CTC–41). Dep. NTIS.

Calculations were made of the spatial and neutron energy dependence of the neutron captures and inelastic scatterings that contribute to the secondary gamma-ray dose transmitted through a laminated tungsten (Hevimet) and lithium hydride shield adjacent to a SNAP reactor. Four shield configurations were considered: a 5-cm-thick slab of Hevimet alone; the Hevimet followed by a 30.5-cm thickness of LiH; the Hevimet preceded by the LiH; and the Hevimet preceded and followed by the LiH. For each configuration both a forward calculation and an adjoint calculation were performed with the one-dimensional discrete ordinates code ANISN, the forward calculation yielding neutron fluences within the shield and the adjoint calculation yielding probabilities that a gamma ray of a given energy originating at a given position in the shield would contribute to the transmitted dose. The results from the two calculations were convoluted with gamma-ray production data to determine the spatial distribution of the neutron interactions contributing to the exit secondary gamma-ray dose. The calculations show, as was expected, that in each configuration essentially all of the exit secondary gamma-ray dose is due to neutron interactions in the Hevimet, with the contribution from the last half of the Hevimet being a factor of 3 to 5 higher than that from the first half. When LiH follows the Hevimet, 80% of the exit gamma-ray dose is produced by neutron captures, with nearly half of them occurring at neutron energies between 3.06 eV and 0.111 MeV. When LiH does not follow the Hevimet, the importance of neutron inelastic scatterings approaches that of the captures. 10 references. (auth)

35565 COMPARISON OF CONVENTIONAL AND NUCLEAR POWER OPERATED CONTAINER SHIPS, AS SEEN FROM THE ECONOMIC POINT OF VIEW. A CRITICAL COMMENT ON THREE STUDIES. Schmidt, K. E. Schiff Hafen; 23: No. 8, 616-19(1971). (In German).

A critical comment is given on three comparative economy studies. The comparability is considerably restricted, owing to important differences regarding the various presumptions. The peculiarities to be considered in ship engineering and their economic consequences in connection with nuclear propulsion are given special attention. A critical consideration of the total costs shows that up to now, there is no clear advantage to be stated for nuclear power driven ships, as compared to conventionally driven container ships. It seems possible, however, that a slight increase of the oil prices will be sufficient to bring about the break-even-point. (INIS)

35566 DESIGN PROGRAM FOR SECONDARY RADIATION SHIELDING OF THE NUCLEAR-POWERED SHIP MUTSU. Kawai, Yasuhiko (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen; No. 85, 2112-37(Nov 1970). (In Japanese).

Progress of the design program for radiation shielding of the Mutsu is described. At fundamental design stage, it was decided to use concrete for radiation shielding of reactor room, lead-polyethylene for upper part of containment vessel and iron for radiation shielding of the reactor auxiliary room. Calculation of radiation shielding was carried out to investigate shielding thickness. At improved design stage, layout of secondary radiation shielding was same as that of the previous stage, but lead-polyethylene shielding for the upper part of the containment vessel could be reduced in thickness because status of the upper part of the opening of the reactor room, rooms around the reactor room and passage on the upper deck was changed from safety area to circumferential watch area. At modified design stage, results of experiments carried out with JRR-4 were taken into consideration in designing the secondary radiation shielding. It was decided that radiation shielding for the reactor auxiliary room is removed, and machinery and equipment are shielded directly. Moreover shielding of penetrations of ducts, etc., was considered referring to the experimental date. At detailed design stage, problems on radiation shielding were investigated in detail from standpoints of easiness of construction, reduction of shielding weight, partial leakage of radiation and relation between the radiation shielding and structure of the ship. At this stage, thickness of the polyethylene for the upper part of containment vessel was changed from 100mm to 150mm referring to the experimental date. (Japan)

Process Heat and Desalination Reactors

Refer also to abstract 33122.

35567 HYDROGENATING GASIFICATION OF BROWN COAL USING THE HEAT OF HIGH TEMPERATURE REACTORS. Huettner, R.; Teggers, H. (Union Rheinische Braunkohlen Kraftstoff AG, Wesseling, Ger.). Braunkohle; No. 4, 134-8 (1971). (In German).

The high heat consumption is a considerable cost factor of the gasification of coal. Using the cheap heat from nuclear fission offers the possibility of making coal gasification competitive. A cooperation model has been drafted with the aim to provide feasible plans for such a plant with HTGR's (950–1200°C). The results of theoretical and experimental testing of the hydrogenating gasification are given. (INIS)

Research and Test Reactors

Refer also to abstracts 33246 and 35492.

35568 (AEEW-M-623) PILOT EXPERIMENTAL INVESTIGATION INTO BURNOUT WITH SUBCOOLED WATER FLOWING INSIDE A TUBE AT HIGH VELOCITY. Little, R. B.; Trenberth, R. (Atomic Energy Establishment, Winfrith (England)). Mar 1966. 12p. Dep. NTIS (U. S. Sales Only).

Burnout heat flux data are reported for a 21-inch long round tube with uniform axial heating. A range of mass velocity from 1.5 to 7.0×10^6 lb/hr ft^2 was covered with nominal inlet water conditions of 560 p.s.i.a. and 370 BTU/lb subcooled enthalpy. A linear relationship was obtained between the burnout heat flux values and the mass velocity, good agreement being obtained between the experimental values and the correlation recommended by Tong for subcooled exit conditions. 5 references. (auth)

35569 (ANL-7692) MARK-II INTEGRAL SODIUM TREAT LOOP. Robinson, L. E.; Purviance, R. T.; Schmidt, K. J. (Argonne National Lab., Ill.). Nov 1971. Contract W-31-109-eng-38. 66p. Dep. NTIS.

Performance of fast reactor safety experiments in which oxide fuel is melted and failed in the presence of sodium coolant requires special test techniques. The engineering criteria, design, fabrication, and prototype testing of the Mark-II Integral Sodium Loops developed for studying LMFBR oxide-fuel behavior under transient testing to failure in the TREAT reactor are described. The basic design point is a rating of 5000 psi at 1000°F. 11 references. (auth)

35570 (ANL-7928) RESULTS OF MONTE CARLO CALCULATIONS FOR ZPPR ASSEMBLY 2. Fillmore, F. L. (Argonne National Lab., Ill.). Mar 1972. Contract W-31-109-eng-38. 24p. Dep. NTIS.

Results are presented from two Monte Carlo calculations made with the VIM code for ZPPR Assembly 2. Distinctive features of the VIM code and its cross-section library are described. The cross-section library is based on ENDF/B Version-II data. A description of the problem model used in the calculations is given as well as information concerning computer requirements for making these calculations. The Monte Carlo results are compared with experimental results where available and with results from a two-dimensional, diffusion-theory, multigroup calculation. (11 references) (auth)

35571 (BNL-tr-475) EXTRACTION OF ULTRACOLD NEUTRONS FROM THE REACTOR. Golikov, V. V.; Lushchikov, V. I.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P3-3036. 14p. Dep. NTIS.

Neutrons with energy near 10^{-7} eV were produced in the cold neutron channel of the IBR-30 pulsed reactor. The neutrons were emitted from a thin plate converter irradiated in a thermal neutron flux. The calculated and measured neutron yields are presented. (8 references) (H.D.R.)

35572 (DOCKET-50231-118) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. License Amendment 2, Technical Specifications, Change 12. (Directorate of Licensing (AEC), Washington, D. C.). 12 May 1972. 73p. Dep. NTIS.

Revised technical specifications are presented concerning the shutdown status of the reactor. (D.C.C.)

35573 (GKSS-71/E/11) CALCULATION OF THE FRG. PART II. CATALOG OF FUNDAMENTAL DATA FOR THE 23-PLATE MTR FUEL ELEMENT WITH 180 g OF ^{235}U. Boebs, J.; Krueger, A.; Mueller, A. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Hamburg (West Germany)). 1971. 80p. (In German). Dep. NTIS (U. S. Sales Only).

Compiled are basic data for the MTR fuel element used in the FRG. The element contains 23 plates and 180 g ^{235}U. The data originates from construction experience and from specifications of the manufacturer. The data serve as basis for nuclear calculations about the FRG, such as core configurations and experimental inserts. They also are intended for comparison in experimental studies. (tr-auth)

35574 (GULF-GA-B-10776) GULF GENERAL ATOMIC SUPPORT OF THE HIGH TEMPERATURE LATTICE TEST REACTOR PROGRAM DURING FISCAL 1971. Schultz, K. R.; Mathews, D. R. (Gulf General Atomic Co., San Diego, Calif.). Contract AT(04-3)-167. 65p. Dep. NTIS.

The work performed during the period from July 1, 1970 to June 30, 1971 in support of the High Temperature Lattice Test Reactor (HTLTR) program is reviewed. The theory of the experiment is extended and clarified. Updated calculations of HTGR Lattices 1, 2 and 3 are performed. The methods used in analysis of the experiments are studied. A number of corrections and parameters that affect the experimental analysis or calculation are investigated. New derivations of the theory behind the HTLTR experiment are presented. An alternative theory that allows the true infinite medium multiplication factor to be determined experimentally is described. Use of this theory simplifies the calculation of k_∞ and makes experimental determination of k_∞ easier. 21 references. (auth)

35575 (HEDL-TME-72-22) SHUTDOWN REACTIVITY MEASUREMENTS IN FTR-CRITICAL EXPERIMENTS EVALUATION. Fleischman, R. M.; Bennett, R. A. (Hanford Engineering Development Lab., Richland, Wash.). Mar 1972. Contract AT(45-1)-2170. 34p. Dep. NTIS.

The subcritical reactivity measuring concept proposed for the Fast Test Reactor (FTR) is evaluated using data from a series of zero-power critical experiments performed as part of the FFTF Critical Experiments Program at Argonne National Laboratory. The ability of two-dimensional diffusion theory to correct the well-known source multiplication technique for reactor spatial effects which cause departure from fundamental mode behavior is tested. A comparison of results with inferred core reactivities as low as −33$ is given. (10 references) (auth)

35576 (IAEA-130) ENGINEERING PROGRAMS IN RESEARCH REACTORS. Proceedings of a Panel, Vienna, July 27–31, 1970. (International Atomic Energy Agency, Vienna (Austria)). 1971. vp. (In several languages). INIS.

For abstracts of individual papers see: 35577–35599.

35577 (IAEA-130, pp 1-15) ENGINEERING PROGRAMMES IN RESEARCH REACTORS. Background Paper. Kolbasov, B.; Gonzalez-Montes, H. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720-6). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A short review of the need for engineering knowledge in the nuclear power field and its possible achievements through the use of research reactors, aiming both at the creation of a good basis for engineering development and the better utilization of the existing reactor centers in developing countries is presented. The Agency's long-standing active program in research reactor utilization and its relevance to engineering studies in reactors are briefly described. The goals of the Panel on Engineering Programs in Research Reactors and a review of the areas of engineering suggested for the research reactors in developing countries are presented. The problems of interdependence of nuclear power programmes and nuclear engineering research are also treated. (auth)

35578 (IAEA-130, pp 33-53) THE WHITESHELL NUCLEAR RESEARCH ESTABLISHMENT: ITS SIGNIFICANCE AND DEVELOPMENT. Mooradian, A. J. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720-10). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A case study of an isolated nuclear research laboratory on the Canadian prairies is presented. The considerations leading to the synthesis of its programs and the logistics associated with their execution should be of interest to countries considering their own requirements for such laboratories in support of national nuclear energy programs. (auth)

35579 (IAEA-130, pp 55-60) ORGANISATION AND FUNCTION OF DESIGN SERVICES DEPARTMENT OF RESEARCH REACTORS DIVISION. Taylor, F. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720-22). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

The number of staff involved, the organization used, and the policies adopted, in carrying out the engineering programs necessary in research reactors at A.E.R.E. in support of the U.K. power program are indicated. Since the organization and policies are based on many year's experience, it is suggested that the information is useful to smaller organizations operating in similar fields of endeavor. (auth)

35580 (IAEA-130, pp 63-7) STATUS REPORT OF THE ENGINEERING PROGRAMMES AT THE REACTOR CENTER, SEIBERSDORF, AUSTRIA. Burtscher, A. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720-1). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A review of the engineering programs, which are carried out at the ASTRA Reactor, is given. Furthermore, those programs are listed which are made in cooperation with the Austrian industry at the research center. (auth)

35581 (IAEA–130, pp 69-72) A BRIEF NOTE ON THE USE OF RESEARCH REACTORS AT A.E.R.E. Taylor, F. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–23). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

The U.K. power programme has been discussed in many recent technical papers and journals. A program of this magnitude demands supporting programs which must be carried out in available research reactors. These supporting programs cover a broad complex spectrum of work. The research reactors being used, the work load involved, staffing requirements, and comparative costs are indicated briefly. (auth)

35582 (IAEA–130, pp 73-85) SUMMARY OF THE ENGINEERING PROGRAMMES PERFORMED IN THE BELGIAN RESEARCH REACTORS. Stiennon, G. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–18). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A survey of the engineering programs conducted in the Belgian research reactors is presented. The Venus critical facility is used for experimental determinations related to the plutonium recycling in thermal reactors. The low flux BR-1 reactor is used for activation analysis and reactor physics calibrations. The high flux BR-2 reactor is mainly used for fuel and structural material tests for fast reactor and high temperature reactor programs. The BR-3 reactor, a small PWR power plant, is used for large scale testing of fuel elements for thermal water reactors. (auth)

35583 (IAEA–130, pp 87-98) RESEARCH REACTOR FACILITY INSTALLATION IN A DEVELOPING COUNTRY. Spitalnik, J. (International Atomic Energy Agency, Vienna (Austria)). 1971. (In Spanish). (CONF-700720–17). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

The creation of a nuclear research center in Uruguay that would unify the dispersed efforts being carried out in several fields of nuclear energy applications had to face two alternatives: either to buy a 1 MW research reactor package from a foreign manufacturer or to try to install it through local engineering, labor and finance. It was considered that the second alternative was the most convenient for introducing new technology to and developing the industrial potential of the country. The experience gathered by making this effort could point to some of the difficulties an engineer of a developing country might encounter in a similar situation. (auth)

35584 (IAEA–130, pp 99-107) ENGINEERING PROGRAM AT THE FINNISH TRIGA RESEARCH REACTOR. Palmgren, A. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–11). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A description is given of the field of nuclear power and nuclear technology in Finland. The planned nuclear power program is indicated. The research projects of the only Finnish reactor research establishment are presented. The research policy of the reactor laboratory is discussed and the organization of the laboratory is shown to indicate the available resources. Some results of an inquiry among Finnish nuclear experts concerning the role of a nuclear engineering program are presented. (auth)

35585 (IAEA–130, pp 139-43) INDIAN NUCLEAR EFFORT: STATUS REPORT. Sundaram, S. M.; Veeraraghavan, N.; Rao, M. R. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–21). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

The Department of Atomic Energy has programmed to install 2700 MWe of nuclear power generating capacity in the country by 1980. In addition to (a) the two reactors (2 × 200 MWe, GE-BWR, TAPS) already in operation at Tarapur (Maharashtra), (b) the two reactors (2 × 200 MWe, CANDU-PHWR, RAPP I and II) in an advanced stage of construction at Kota (Rajasthan) and (c) the two more reactors (2 × 200 MWe, CANDU-PHWR, MAPP I and II) approved for Kalpakkam (Tamil Nadu) and work on which has commenced, it is proposed to augment the nuclear power generating capacity by 1500 MWe by constructing advanced thermal reactors of up to 500 MWe unit size. The engineering facilities available at Bhabha Atomic Research Center, Trombay, and the manner in which they have grown and led to the setting up of various plants elsewhere in the country in the context of the country's nuclear effort, have been highlighted. The emphasis placed on the development of indigenous know-how and creation of ability to solve technical problems with minimum foreign assistance has not only provided a strong engineering base required for the nuclear power program, but also has acted as a catalyst in the scientific and technological advancement of the country. (auth)

35586 (IAEA–130, pp 145-58) AECL'S ENGINEERING PROGRAMS IN RESEARCH REACTORS. Robertson, J. A. L. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–13). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

Experience has taught the value of well designed research reactors. These should be associated with versatile facilities for the fabrication and subsequent examination of test specimens. The facilities can grow with the program and even the reactor can evolve as required. The experimental program, if judiciously selected, can be of immense value in either of two ways: (1) By providing, in miniature and at an early stage, almost all the problems to be met in designing and commissioning a power reactor, and (2) By developing the necessary expertise to formulate a national program for nuclear power. (auth)

35587 (IAEA–130, pp 179-89) ENGINEERING ACTIVITIES IN THE JEN-1 RESEARCH REACTOR. Montes Ponce de Leon, J. (International Atomic Energy Agency, Vienna (Austria)). 1971. (In Spanish). (CONF-700720–9). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A brief description of Spain's nuclear program is given, referring to the utilization of the JEN-1 reactor in nuclear engineering. Development of the detection system, control and instrumentation, as well as the testing of fuel elements have been the active topics within the engineering field. Personnel training for the nuclear power plants has also been an important activity. A brief description of the changes made in JEN-1 reactor as well as the reasons which induced such modifications are given. (auth)

35588 (IAEA–130, pp 191-9) ENGINEERING PROGRAMMES IN THE ARGENTINIAN REACTORS. Cosentino, J.; (and others) (International Atomic Energy Agency, Vienna (Austria)). 1971. (In Spanish). (CONF-700720–2). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A general review of the engineering activities carried out in Argentina in connection with the Argentine Nuclear Reactors is presented. The present national participation in the Atucha Nuclear Power Plant Project is particularly mentioned. (auth)

35589 (IAEA–130, pp 201-14) SOME EXAMPLES OF RESEARCH REACTOR UTILIZATION COSTS AND TRENDS IN THE U.S. NOTES. Lennox, D. H. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–8). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

New research reactor facilities in the U. S. are reviewed briefly; typical engineering development problems, with emphasis on the LMFBR, are listed. Examples of the utilization of various types of research reactors are given, and engineering experiments suitable for low power reactors are tabulated. Costs associated with selected reactors and typical experiments are listed to provide some perspective for potential reactor customers and experimenters. Thoughts about schemes for cost reduction are included. (auth)

35590 (IAEA–130, pp 217-24) SCOPE AND POSSIBILITIES OF ENGINEERING PROGRAMMES IN THE U.A.R. RESEARCH REACTOR. El-Fouly, M. F. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–3). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A brief description of the several problems that faced the U.A.R. Atomic Energy Establishment in the preparation of trained personnel and equipping laboratories is presented. A description of the research work taking place in the fields of control, heat transfer and material properties is given. Most of the research work in process is meant to support the goal of designing a single purpose reactor for desalination. (auth)

35591 (IAEA–130, pp 225-30) USE OF THE RESEARCH REACTOR IN BULGARIA FOR SOLVING NUCLEAR POWER PROBLEMS. Georgiev, R. (International Atomic Energy Agency, Vienna (Austria)). 1971. (In Russian). (CONF-700720–4). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A survey is made of the work which has been, and is being, carried out at the research reactor in Bulgaria for solving problems of nuclear technology. Special attention is devoted to nuclear power studies. Of the problems being handled, those which are connected directly with the construction of nuclear power stations are enumerated in detail. Mention is also made of the methods used for training nuclear power station personnel. (auth)

35592 (IAEA–130, pp 231-56) USES OF TRIGA RESEARCH REACTORS FOR ENGINEERING, RESEARCH, TESTING, AND TRAINING. Schnurer, G. T.; McMain, A. T.; Fischer, P. U. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–15). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A brief survey is made of the utilization of research reactors for engineering applications which has been based largely on experiences with three TRIGA reactors at Gulf Energy and Environmental Systems, Inc. (GE&ES) and also from the experience occurring from the installation and operation of nearly fifty TRIGA's throughout the world. The paper treats briefly a number of different applications which illustrate ways in which a relatively low-power reactor such as TRIGA can be employed productively in engineering research. This paper also illustrates an important characteristic of all research reactors: they are interdisciplinary tools that can be used in a variety of different fields. Since many countries embarking on a nuclear power program do not have access to expensive high-flux multimegawatt test reactors, examples have been chosen from reactors operating at a power level of 1 MW and below to demonstrate how much reactors can be used in support of engineering research particularly as it relates to nuclear power development. (auth)

35593 (IAEA–130, pp 257-69) SUMMARY OF THE CURRENT ENGINEERING PROGRAM IN THE 50-MW R2 REACTOR. Saltvedt, K. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–14). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A brief description is given of the irradiation facilities and the associated experimental equipment used for engineering activities in the R2-reactor. Costs are given for some of the most complex facilities. The irradiation program for the period 1/7/1970 to 30/6/1971 with a brief description of the different experiments is presented. (auth)

35594 (IAEA–130, pp 271-84) MANPOWER REQUIREMENTS AND ENGINEERING PROGRAMS USING RESEARCH REACTORS IN CONJUNCTION WITH NUCLEAR POWER REACTOR PROCUREMENT. Kleijn, H. R. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–5). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

The manpower requirements in governmental agencies, utilities and industry as well as the function of national research establishments and universities in relation to the procurement and operation of nuclear power plants in a developing country are discussed. Further, various types of general purpose research reactors are analyzed in terms of their potential for training and research programs. Cost figures of the operation of these reactors are given. Following a few remarks on the required research environment infrastructure a number of research projects are proposed. General recommendations on the subject matter to developing countries close the paper. (auth)

35595 (IAEA–130, pp 285-94) RESEARCH REACTOR UTILIZATION IN THE CONTEXT OF NUCLEAR POWER PROGRAMME IN DEVELOPING COUNTRIES. Sundaram, S. M.; Veeraraghavan, N.; Rao, R. R. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–20). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

Problems of developing countries in the engineering utilization of research reactors in the context of their nuclear power program have been highlighted. These reactors may be profitably utilized in such fields of technology as development of nuclear and radiation instruments, radioactive waste management etc. However, research utilization in developing countries for fuel and material development has certain limitations due to absence of a clear cut nuclear power program, inadequate conventional engineering base and lack of engineering test facilities. The paper highlights how India has tried to solve the problems to reach a stage when fuel and material development with in-pile irradiation facilities can be undertaken within the country. (auth)

35596 (IAEA–130, pp 295-301) REVIEW OF RESEARCH REACTORS, THEIR USE AND SOME ENGINEERING PROGRAMS IN GERMANY. Kueper, K. D. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–7). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

Nuclear research reactors have played and will continue to play an important role in support of a nuclear power program. In addition to the obvious aspects of training personnel for associated work with a nuclear power plant, the vital contribution of research programs, conducted to support a power development program, cannot be disregarded. Furthermore, a significant aspect of the use of nuclear research reactors is the field of isotope production and use of reactors as neutron sources. Thereby, research reactors become essential tools in nuclear medicine, biology, chemistry and many other engineering fields. The latter points can be of great interest for developing countries which are not interested in establishing their own nuclear industry. The first part of the following paper presents a short survey of the existing research reactors and their use in Germany. Of these, one research reactor of the TRIGA Type, playing a significant role in the field of nuclear medicine, will be separately discussed. The second part of the paper will list some latest developments in the field of nuclear reactor instrumentation, applicable for research reactors and power reactors. In conclusion, some essential features appropriate to a research reactor are recommended. (auth)

35597 (IAEA–130, pp 303-68) IRRADIATION DEVICES. Sequin, M. (International Atomic Energy Agency, Vienna (Austria)). 1971. (In French). (CONF-700720–16). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

Investigation of the different parameters governing irradiation operations (parameters related to samples and their environment and to the reactor used, and thermal and mechanical parameters) produces a general design philosophy for irradiation devices. This philosophy allows a reasonable degree of standardization for many of the components constituting the devices. This degree of standardization has the advantage of permitting the in-pile part of the device to be loaded within several days to one month, depending on the case under consideration, after the experimenter has delivered the samples. Some recent capsules and loops are described in the paper. These devices have always made it possible to meet the most stringent requirements regarding parameters (e.g. temperature, pressure, flow rate) imposed by the experimenters in respect of their samples. (auth)

35598 (IAEA–130, pp 379-82) PROBLEMS INVOLVED IN THE PROCUREMENT OF IN-PILE ASSEMBLIES FOR NUCLEAR RESEARCH. Straton, R.; Taylor, F. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–19). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

The task of providing equipment for carrying out irradiation programs has many restraints, restrictions and difficulties. It is suggested that they can be reduced to a minimum by the type of organization referred to in another paper. (auth)

35599 (IAEA–130, pp 383-5) SOME ASPECTS OF THE UTILIZATION OF THE ROMANIAN RESEARCH REACTOR IN NUCLEAR ENGINEERING. Popa, P. (International Atomic Energy Agency, Vienna (Austria)). 1971. (CONF-700720–12). INIS.

From Engineering programs in research reactors symposium; Vienna, Austria (27 Jul 1970).

A brief review is given of the principal research activities on nuclear engineering which have been carried out on the Romanian 3.5-MW reactor. Material trials and burn-up studies relating directly to analyses of nuclear data have been undertaken in conjunction with research on reactor control and heat transfer. (auth)

35600 (ORNL-TM-3826) HIGH FLUX ISOTOPE REACTOR QUARTERLY REPORT, JANUARY–MARCH 1972. (Oak Ridge National Lab., Tenn.). 5 May 1972. Contract W-7405-eng-26. 22p. Dep. NTIS.

Reactor operation was routine this quarter with an on-stream time of 95.2%. The semiannual reactor component inspection was completed and the control plates were changed. An in-situ, ultrasonic inspection technique was developed to check the reactor vessel head studs for incipient cracks. All reactor vessel top head studs were checked and the three with the largest indications of anomalies were replaced. (auth)

35601 (SC-M-710227-B) OPERATING MANUAL FOR SANDIA PULSED REACTOR II. Snyder, John A. (Sandia Labs., Albuquerque, N. Mex.). Apr 1972. 26p. Dep. NTIS.

A manual intended for use by persons operating Sandia Pulsed Reactor II is presented. Its purpose is twofold: to provide a guide for operation of the reactor and auxiliary equipment, and to summarize the information about the facility required to qualify as a reactor operator. (auth)

35602 (WASH-1514) POWER BURST FACILITY, NATIONAL REACTOR TESTING STATION, IDAHO. Environmental Statement. (Atomic Energy Commission, Washington, D. C.). Apr 1972. 125p. Dep. NTIS.

Information concerning radioactive discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological and hydrological data for the reactor site are included. Cost-benefit analysis of reactor operation is presented. (D.C.C.)

35603 IN-REACTOR CREEP MACHINE FOR HIGH FLUX APPLICATIONS. Fidleris, V.; Emmerton, I. R.; Delaney, R. D. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Phys., E (London); 5: No. 5, 442-4(May 1972).

A stable, sensitive in-reactor creep machine is described suitable for operation in the temperature range 200 to 800°C and for nuclear heating rates up to 3 W g^{-1} in steel. (auth)

35604 SPECTRAL DISTRIBUTION OF NEUTRONS AND NEUTRON REACTION CROSS SECTIONS IN AN UNREFLECTED ^{235}U CRITICAL ASSEMBLY AND THE FISSION NEUTRON SPECTRUM. McElroy, W. N. (WADCO Corp., Richland, Wash.); Armani, R. J.; Tochilin, E. Nucl. Sci. Eng.; 48: No. 1, 51-71(May 1972).

Inconsistencies between activation detector and n,p scattering/time-of-flight (TOF) measurements of the thermal-neutron-induced ^{235}U fission spectrum prompted a comparison of such measurements in the core center and on the surface of a bare ^{235}U assembly, referred to as Godiva. For the study, TOF measurements and multiple foil measurements of the core and surface spectra of the APFA-III-Godiva are compared. Comparison of the integral fluxes above specified energies for the two methods shows agreement to within ~5% at core center. Results obtained at ½ in. from the core surface, however, show disagreement between the multiple foil and TOF (and previously reported photo-plate data) which is similar to that found for measurements in the fission spectrum. Results for the fission spectrum are re-analyzed using the same evaluated energy-dependent cross sections as used for the Godiva study but with a larger number of foil reactions than previously available. A Monte Carlo error analysis code is used for the assignment of errors for the activation results for the Godiva and fission spectrum studies. It is concluded that if the activation measurements of the Godiva and fission spectrum remain firm, and significant changes in current evaluated reaction cross sections are not effected, then increases up to as much as 10 to 15% in the mean energy of the Godiva leakage and fission spectrum must be considered. (76 references) (auth)

35605 MEASUREMENT AND ANALYSIS OF NEUTRON SPECTRA IN A FAST SUBCRITICAL ASSEMBLY CONTAINING ^{235}U, ^{238}U, AND BERYLLIUM OXIDE. Young, J. C.; Neill, J. M.; d'Oultremont, P.; Slaggie, E. L.; Preskitt, C. A. (Gulf Radiation Tech., San Diego, Calif.). Nucl. Sci. Eng.; 48: No. 1, 45-50 (May 1972).

Neutron spectra were measured between 50 eV and 8 MeV by the time-of-flight method in the core of a fast subcritical assembly, designated STSF-1A. This core is loaded with plate-type elements consisting of BeO, enriched uranium, and depleted uranium. The measurements were made at the surface of the central BeO plate. Reduction of the data and comparison to transport calculations followed the procedures used for the STSF-2 and STSF-2A assemblies. The STSF-1A is similar in most significant details to ZPR-3 Assembly 57, in which the spectrum was measured with a proton recoil detector, and this similarity permitted a comparison of the time-of-flight and proton-recoil techniques. The two methods are found to be generally in satisfactory agreement. (9 references) (auth)

35606 SURFACE CONTAMINATION OF VVR-M REACTOR FUEL ELEMENTS BY FISSIONING MATERIAL AND AN ESTIMATION OF ITS CONTRIBUTION TO THE FISSION FRAGMENT ACTIVITY OF THE COOLANT. Badanina, N. G.; Konoplev, K. A.; Saikov, Yu. P. At. Energ. (USSR); 32: No. 4, 316-18(Apr 1972). (In Russian).

Surface contamination of fuel elements during fabrication is commonly held to 10^{-8} g U/cm^2. Subsequent neutron irradiation results in fission product activity on the surface of fuel elements. A method is described for determining the distribution of surface contamination in terms of g of ^{235}U/cm^2. The contribution of fission product activity to the water in the cooling loop may be derived from the formula given. (K.S.W.)

35607 VACUUM LEAD SEALING FOR REACTOR EXPERIMENTS. Schreckenbach, K.; Mampe, W.; von Egidy, T. (Technische Univ., Munich). Atomkernenergie; 19: No. 3, 260(May 1972). (In German).

35608 ANALYSIS OF INTERNAL HEATING SHOCK EFFECTS IN REACTOR FUEL COMPONENTS. Reuscher, J. A. (Sandia Labs., Albuquerque, N. Mex.). Nucl. Eng. Des.; 18: No. 2, 213-51(1972). (CONF-710903-20).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Under conditions of rapid fission heating, large dynamic stresses may be induced in a reactor fuel component. Various calculational techniques have been developed to determine the expansions and stresses in a specific fuel element geometry. One-dimensional calculational procedures are discussed for a sphere, infinite cylinder, slab, or rod. Two-dimensional techniques for a finite cylinder are also presented. Elastic, elastic-plastic, and elastic-viscoplastic material behavior are included and calculated results are given. Some comparisons between theory and experiment are made for elastic and elastic-plastic analyses in one and two dimensions. (34 references) (auth)

Production Reactors

Refer also to abstracts 33906 and 33972.

35609 (DUN-4078) CONDITIONS FOR MAXIMUM N-PLANT THERMAL AND ELECTRICAL POWER. Conn, W. G. (Douglas United Nuclear, Inc., Richland, Wash.). 5 Apr 1968. Contract AT(45-1)-1857. 14p. Dep. NTIS.

Declassified 27 Oct 1971.

The conditions necessary to operate the N-Plant at maximum thermal and electrical power for a given primary coolant temperature limit are analyzed. To determine these conditions, the basic relations between reactor power, steam pressure, primary coolant temperature and utility electrical power are developed and presented in graphical form. (auth)

35610 (DUN-4131) PRELIMINARY HYDRAULIC STABILITY ANALYSIS. Muraoka, J. (Douglas United Nuclear, Inc., Richland, Wash.). 15 Apr 1968. Contract AT(45-1)-1857. 15p. Dep. NTIS.

Declassified 27 Oct 1971.

Computer programs were developed to examine both the Ledinegg instability and the periodic parallel tube instability in a horizontal, forced convection system. The mathematical approach to solve directly the non-linear conservation equations by finite difference techniques was used. Debug runs made for the proposed Mark IV fuel element indicate that scramming from about 9335 kW after a Ledinegg instability, the maximum fuel element temperature does not exceed the $\alpha-\beta$ transformation temperature of uranium. The calculation is believed conservative since heat transfer beyond burnout was computed assuming the film boiling coefficient was 100 B/hr ft^2 F and constant. An advanced technology case was examined for the parallel tube instability. These results indicate that burnout will supersede instability. When the hydraulic demand curve is stabilized to eliminate the Ledinegg instability, the margin between the burnout power level and instability power level will be significant. It is believed that the margin may be as much as 50%. 5 references. (auth)

35611 (DUN-4190) COMPARISONS OF N REACTOR OPERATING SAFETY LIMITS AND PROCESS STANDARDS LIMITS. Engler, A. E.; Jape, F. (Douglas United Nuclear, Inc., Richland, Wash.). 23 Apr 1968. 13p. Dep. NTIS.

Declassified 27 Oct 1971.

35612 (HW-64003) DESIGN REQUIREMENTS TO REDUCE NPR GRAPHITE TEMPERATURES. Mollerus, F. J. Jr. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 29 Feb 1960. Contract AT(45-1)-1350. 10p. Dep. NTIS.

Declassified 2 Nov 1971.

The present NPR design criteria limits maximum graphite temperature to 1200°C and maximum bulk structural (supporting) graphite temperature to 800°C. The 800°C limit is required to maintain design graphite contraction rate at or below the design rate of 0.02% per 1000 MWD/AT. Recent re-evaluation of the NPR graphite contraction problem indicates that contraction may be greater than the design rate. A discussion of the various means which can be used to reduce graphite temperatures below present design limits is presented. Reduction in graphite temperature will reduce the contraction rate if graphite contraction is temperature sensitive and in addition will reduce process tube surface temperatures. (auth)

35613 (HW–66933) SETTINGS FOR PRESSURE RELIEF SYSTEMS NPR PRIMARY COOLING SYSTEM. Condotta, D. L. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 3 Oct 1960. Contract W-31-109-eng-52. 10p. Dep. NTIS.

Declassified 4 Nov 1971.

Primary protection against pressure relief in the NPR primary loop is obtained by causing a power setback or a reactor scram. It is, however, necessary to provide other conventional pressure relief valves at various places in the piping system. These include: two rupture disks, pressure relief valve combinations at the base of the rear downcomers; dual (either-or) safety-relief valve at the top of the pressurizer; and liquid pressure relief valves located on each heat removal loop to prevent pressure buildup in an isolated loop. Coordinated pressure relief settings for these various valves and rupture disks are recommended. (auth)

35614 (HW–67325) TECHNICAL ASPECTS OF MGCR-HDR-3. Baars, R. E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 4 Nov 1960. Contract AT(45-1)-1350. 16p. Dep. NTIS.

Declassified 5 Nov 1971.

MGCR-HDR-3 is a 19-rod cluster fuel element proposed for the DR-1 third test run. The technical aspects of heat transfer, fluid flow, and fission product release potential are described. (auth)

35615 (HW–72654(Pt.1)) NPR MODERATOR STACK PURITY TESTS. PART I. EXPERIMENTAL VERIFICATION OF ABSOLUTE COUNT RATE METHOD. Wilkinson, C. D. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 20 Apr 1962. Contract AT(45-1)-1350. 21p. Dep. NTIS.

Declassified 2 Nov 1971.

There is a multitude of variables, or boundary conditions, that determine the minimum value of reactivity of a poison lump that will be detected using the absolute count rate method. An extremely sensitive detection system could be designed but in general would not be very practical. In the design of an absolute count rate system a practical balance must be reached between the value of being able to detect a slightly smaller lump of poison and the increased costs in time and capital. In the design of the NPR system this balance was reached at a poison lump reactivity value of 0.05 mk. Although this system would not be expected to detect a 0.05 mk lump in all trials it could be relied upon to detect it well in excess of 90% of the trials. For larger lumps of poison the percentage of detections would approach 100%. (auth) 7

35616 (HW–73282) NPR POWER SETBACK SYSTEM. Bailey, G. F. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 20 Apr 1962. Contract AT(45-1)-1350. 10p. Dep. NTIS.

Declassified 3 Nov 1971.

The power setback system, somewhat of an innovation on a Hanford reactor, is a limited form of automatic process control designed to alleviate certain undesirable conditions likely to be correctable by a reduction in reactivity. It is intended to be used as an operating "tool" with no safety function other than that which can be assumed procedurally by the reactor operator. The design criteria, although necessarily somewhat arbitrary, represent an attempt to incorporate normal operating procedures into an automatic process control system. As a whole, the power setback system conforms to these criteria with few exceptions. These exceptions, along with the entire power setback system and some of the philosophy concerning the design and use of the system, are discussed. (auth)

35617 (HW–77917(Pt.1)) STARTUP TEST N-1 PROCEDURES. N-REACTOR STARTUP PHYSICS TEST PROGRAM: COLD PHYSICS TESTS. Hagan, J. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 22 Nov 1963. Contract AT(45-1)-1350. 145p. Dep. NTIS.

Declassified 2 Nov 1971.

Theoretical calculations normalized to experimental values from exponential and PCTR tests have been used for estimating the experimental results for each test phase. The startup physics tests will be used to verify the preliminary calculations and to define the reactor characteristics within the precision required for safe and efficient subsequent operation of the reactor. Detailed and accepted test procedures are required for maximum test efficiency and reactor safety during performance of the physics test program and for sufficient overall scheduling into the N-Reactor operational test program. Some flexibility of the procedures is provided so that the more efficient alternatives as determined by prior test results may be applied as the testing progresses. Hazards' analyses have been performed and are presented for cases which are unique to the physics startup tests or significantly differ from the Design Hazards Review. As shown in the analyses, hazards associated with the small pile tests (approximately $1/3$ loaded), are more restrictive in some cases than the full pile tests due to the increased potential rates of reactivity inputs from control withdrawals. This requires strict control over the procedures during performance of these startup tests. The cold physics tests are estimated to require from 26 to 38 days of continuous testing time. (auth)

35618 (HW–77917(Pt.2)) STARTUP TEST N-1 PROCEDURES. N-REACTOR STARTUP PHYSICS TEST PROGRAM: HOT LATTICE TEST AND INSTRUMENTATION CALIBRATION. Hagan, J. W. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 5 Dec 1963. Contract AT(45-1)-1350. 33p. Dep. NTIS.

Declassified 2 Nov 1971.

The detailed test procedures for the second and last phase of the N-Reactor startup physics test program are described. The over-all program is outlined, and the detailed procedures for all physics tests prior to the hot lattice test are presented. (auth)

35619 (HW–77921-A) NPR KINETICS (STARTUP) SIMULATION. Swanson, C. D.; Jones, E. D. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 17 Jun 1963. Contract AT(45-1)-1350. 18p. Dep. NTIS.

Declassified 7 Nov 1971.

A description of a simulation of the NPR which has been tested and used to obtain NPR kinetics information in the startup ranges (source through intermediate) is presented. (auth)

35620 (HW–77921-B) NPR SYSTEMS ANALOG SIMULATION. PART B. NPR KINETICS (POWER RANGE). Swanson, C. D.; Coughren, K. D. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 3 Sep 1963. Contract AT(45-1)-1350. 24p. Dep. NTIS.

Declassified 7 Nov 1971.

The process model described consists of the basic kinetics model modified to represent only the power range of operation and to include a simple primary coolant loop model. The principal objective is to provide a model which can be used to study the effects of reactivity, coolant temperature and coolant flow rate disturbances on power level, outlet temperature, fuel temperature, and other related variables. Various scram and power setback functions can be simulated to bracket the true conditions, thus improving the accuracy of maximum hazard estimates and providing a basis for initial instrument trip settings. (auth)

35621 (HW–77921-E) N-REACTOR PRIMARY COOLANT SYSTEM. Swanson, C. D.; Coughren, K. D.; Thieme, G. G. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 3 Feb 1964. Contract AT(45-1)-1350. 20p. Dep. NTIS.

Declassified 2 Nov 1971.

The information necessary to program (patch) a simulation of two parallel N-reactor primary coolant pump groups, the reactor primary coolant hydraulics and a one-delayed group kinetics model on an analog computer is presented. (auth)

35622 (HW–77921-F) NPR SYSTEMS ANALOG SIMULATION. PART F. N-REACTOR STEAM GENERATOR. Swanson, C. D.; Coughren, K. D. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 8 Jan 1964. Contract AT(45-1)-1350. 36p. Dep. NTIS.

Declassified 2 Nov 1971.

The information necessary to program and patch a simulation of the N-reactor steam generator (heat exchanger) using a three-node primary and two-node secondary model is presented. The EASE model 1100 analog computer was used to test and debug the program. (auth)

35623 (HW–78194) N-REACTOR SECONDARY STEAM PRESSURES WITH REDUCED HEAT EXCHANGE AREA. Robinson, R. K. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 17 Jul 1963. 11p. Dep. NTIS.

Declassified 3 Nov 1971.

During the hydrostatic testing of the steam generators, leakage of water from the primary side into the secondary side was noted. It was decided that the leakage warranted a more detailed examination. Subsequently the tubes in all the steam generators were dye and eddy current checked. The results of these tests revealed some cracks and in some cases fairly extensive intergranular corrosion. These test results indicate the possibility that N-Reactor may be operated with reduced heat exchange area due to deliberate plugging of defective tubes and/or extended periods when one or more steam generators are isolated from the system for repairs. Reduced heat exchange area can have a significant effect on the operating steam pressures which have been predicted. Therefore, the effects of reduced heat exchange area on the steam pressure—reactor power level relationship has been studied and is presented. Calculations were made using four different steam generator combinations. The steam pressure-reactor power level relationships using the preliminary test data and also more extreme area reduction assumptions are tabulated and shown along with the previously predicted operating parameters which assumed 100% heat exchange area. (auth)

35624 (HW–78254) PHYSICS STUDY OF ^{238}Pu PRODUCTION CAPABILITIES IN N-REACTOR. Mills, E. E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 15 Jul 1963. Contract AT(45-1)-1350. 14p. Dep. NTIS.

Declassified 2 Nov 1971.

The nuclear characteristics of N-Reactor and the relatively large volumes which could be made available for irradiation of target material indicate that production of ^{238}Pu might be an efficient use of the reactor. High flux values are desirable for ^{239}Pu production. The calculations seem to indicate that the best results would be obtained by using flux traps and a recycle program. Although the use of short irradiation time gives higher ultimate conversion of target material, this is accompanied by higher separation and fabrication costs. Conversely, the longer exposure periods give lower processing costs, as well as faster production, but lower ultimate conversion of ^{237}Np. ^{237}Np losses would be quite small (approximately 10%) at an exposure period of 1.5 months, but would climb to about 30% for a 6 month period. Increased burnout of the ^{238}Pu product would seem to make irradiations of 12 months or more undesirable. The 3 and 6 month irradiation cycles seem the most promising. Assuming no loss of product in chemical separations or fabrication, an equilibrium output of ^{238}Pu running up to 70 or 80% of new feed input should be attainable in a recycle program. (auth)

35625 (HW–78426) STARTUP TEST N-1: N-REACTOR STARTUP PHYSICS TEST PROGRAM. Hagan, J. W.; Nechodom, W. S. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 1 Aug 1963. Contract AT(45-1)-1350. 84p. Dep. NTIS.

Declassified 2 Nov 1971.

The scope of the startup physics test program, the general testing procedures, and hazards analyses significant to the startup physics tests are presented. (auth)

35626 (HW–82262) N-REACTOR NEUTRON NOISE MEASUREMENT RESULTS. Swanson, C. D. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 13 May 1964. Contract AT(45-1)-1350. 9p. Dep. NTIS.

Declassified 2 Nov 1971.

The test results indicate that useful kinetics data cannot be obtained at the N-reactor by the "reactor noise" technique, using one chamber. The multiple-chamber technique has not been evaluated. It should be noted that this test does not preclude the use of random test signals and simultaneous analysis or recording of the resulting random response signals as a valid method of obtaining N-reactor kinetics data. (5 references) (auth)

35627 (HW–83176) ANALOG SIMULATION OF THE HANFORD N-REACTOR PLANT. PART 2. DATA FOR PROGRAMMING THE OVER-ALL SIMULATION MODEL. Coughren, K. D.; Dionne, P. J.; Thieme, G. G. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). 2 Dec 1964. 73p. Dep. NTIS.

Declassified 2 Nov 1971.

Results of a major program to study performance characteristics of Hanford N-plant are presented. Included are scaled simulation diagrams and other information needed to duplicate the N-reactor plant model. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 33288, 33306, 33840, 33843, and 33920.

35628 (KFK–1390) SEVERAL VARIATION PRINCIPLES OF CREEP MECHANICS AND THEIR USE ON THE CREEP COLLAPSE PROBLEM OF FUEL ELEMENT CLADDINGS. Malmberg, T. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Dec. 1971. 134p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Karlsruhe Univ., Ger.

The development of general variational principles of creep mechanics, their specialization for thin shells, and the application of these principles to the approximate solution of the creep collapse of fuel element claddings are described. Results of investigations using the principles indicate that the creep collapse time is practically not affected by the details of the stress distribution across the cladding. This was shown by comparison with results obtained by the use of the double membrane model. Thermal stresses produce only a minor decrease of the creep collapse time. Nonrotationally symmetric temperature fields which are due to the close packed bundle geometry or due to the fuel rod eccentricity do influence strongly the collapse time. A design which is based on the maximum temperature in the middle of the cladding is well on the safe side, however might be easily too conservative. (68 references) (auth)

35629 (RDT-E-3-7-T(3-72)) RECIPROCATING POSITIVE DISPLACEMENT PUMP. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 16p. RSO.

Requirements are presented for a horizontally or vertically mounted reciprocating power pump for service in a pressurized water-cooled nuclear reactor system. The criteria include the strength and pressure integrity of the pump structure and the operability and reliability over the required lifetimes of single, duplex, triplex, and multiplex type pumps and their components. (auth)

35630 (RDT-E-10-5-T(3-72)) EXPANSION JOINT—CONTAINMENT VESSEL AIRLOCK. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Mar 1972. 18p. RSO.

The design, materials, fabrication, field assembly, inspection, test, and quality assurance requirements for bellows-type expansion joints in nuclear reactor containment vessel airlocks are presented. Expansion joints constructed in accordance with this standard will meet the requirements for Class MC components given in Section III of the ASME Boiler and Pressure Vessel Code. (auth)

35631 NUCLEAR REACTOR FUELLING INSTALLATIONS. Emerson, David Colin (to United Kingdom Atomic Energy Authority). British Patent 1,268,487. 29 Mar 1972. Filed 9 Aug 1968.

In conventional arrangements reactor refuelling connections constitute a potential weakness in the reactor coolant circuit. In the arrangement described a pressure containing envelope is provided around a detachable connection, outside the containment structure, to the refuelling machine, isolated from the reactor cooling circuit. This envelope extends to enclose both the refuelling machine and the connection, with a connecting duct extending between the envelope and the containment structure, so that the envelope forms an extension to the containment structure. The refuelling machine comprises a nose unit and a detachable flask. (UK)

35632 IMPROVEMENTS IN NUCLEAR FUEL ELEMENTS. Rigg, Shepherd (to United Kingdom Atomic Energy Authority). British Patent 1,271,644. 19 Apr 1972. Filed 24 Jul 1968.

Reference is made to sheathed nuclear fuel elements. In the element described the sheath has an internal periphery in the shape of a closed three-sided figure having equilateral curved sides. The corners may be sharp or radiused. Expansion of the fuel can be accommodated by change of shape of the sheath, without significant stretching of the circumferential dimensions, and since the sheathed fuel is of substantially circular cross section stress concentrations in the sheath are small. (UK)

35633 METHOD OF MAINTAINING UNDER TENSION HOOPS FOR PRESTRESSING HOLLOW BODIES. Puyo, Andre; Picaut, Jack; Costes, Didier; Dupay, Francis; Saglio, Robert (to Commissariat a l'Energie Atomique). French Patent 2,068,000. 26 Jul 1971. Filed 25 Nov 1969. (In French).

A procedure for maintaining under tension the hoops used to prestress hollow bodies (e.g. a nuclear reactor vessel) is described. The hoops consist of several superposed spiral windings of a metallic strip under tension. This tension is controllable. The device used for the winding is described. The tension is produced from the free end of the strip by passage between a pair of tightly pressed rollers which impedes the rotation. (France)

35634 CONTROL ROD POSITION INDICATION SYSTEM. Barton, Donald R. (to United States Atomic Energy Commission). U. S. Patent 3,649,450. 14 Mar 1972. Filed 4 Mar 1970.

The position and motion of a control rod are measured by pulse techniques. The magnetic properties of the control rod are varied along its length and the rod forms part of the magnetic circuit of a sensing device. Motion of the rod causes changes in the magnetic structure of the sensing device to develop pulses which are processed by standard pulse techniques. (Official Gazette)

35635 ANALYTICAL STUDY OF HEAT TRANSFER TO LIQUID METALS FLOWING PARALLEL THROUGH TIGHTLY PACKED FUEL ROD BUNDLES. Marchese, A. R. (Atomics International, Canoga Park, Calif.). Contract AT(04-3-701. pp 15-29 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

An analytical study is presented of heat transfer in triangular arrays of packed (P/D = 1.00) fuel rods cooled by liquid metals in turbulent longitudinal flow. Fully developed velocity and temperature profiles are considered. Since the turbulent transport of heat is neglected, the analysis is restricted to Peclet numbers less than the critical value. Simultaneous solution of the differential energy equations for the coolant and various fuel element regions was accomplished numerically with the aid of a digital computer. Dimensionless results are presented for the Nusselt number and azimuthal temperature and heat flux variations. By considering variations in the relative thermal conductivities of the fuel, cladding, and coolant, as well as the effects of cladding thickness and an intermediate gas gap; the study covers a range of fuel element-liquid metal coolant combinations of practical interest. The theoretical predictions of the study are compared with experimental data published by workers in the USSR. (11 references) (auth)

35636 TURBULENT FLOW THERMAL-HYDRAULIC CHARACTERISTICS OF HEXAGONAL PITCH FUEL ASSEMBLIES. Oberjohn, W. J. (Babcock and Wilcox Co., Alliance, Ohio). pp 30-40 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

A method for predicting radial and circumferential velocity and temperature distributions for fully developed single-phase turbulent flow in a fuel assembly unit cell is described. The analysis consists of a numerical solution of the conservation of momentum and energy equations. Predictions are in good agreement with existing analyses and in reasonable agreement with data for both liquid metals and air. Results are presented showing the effect of fuel pin pitch-to-diameter ratio on heat transfer and pressure drop at typical LMFBR coolant conditions. The corresponding fuel pin circumferential heat transfer coefficient and shear stress distributions are also presented. (29 references) (auth)

35637 EFFECT OF ROD DISPLACEMENT ON HEAT TRANSFER IN SLUG FLOW THROUGH UNBAFFLED ROD BUNDLES. Hsu, Chia-jung (Brookhaven National Lab., Upton, N. Y.). pp 58-68 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

A theoretical study has been carried out to explore the effect of rod displacement on heat transfer in slug flow through triangular rod clusters. Consideration is given to displacing a rod from its symmetrical position, first, toward an adjacent rod, and second, toward the midpoint of the line connecting the centers of two neighboring rods, by some fraction, σ, of the maximum distance possible for the displacement. The analyses are carried out for the thermal boundary conditions of: (1) uniform wall temperature in the circumferential direction and uniform wall heat flux in the axial direction, and (2) uniform wall heat flux in all directions. From the explicit temperature solutions, the average Nusselt numbers of the displaced rod are calculated for rod bundles having P/D (pitch-to-diameter) ratios in the range of 1.0 to 1.9 and for σ varying from 0.0 to 0.9. It was found that, for heat transfer subject to boundary condition (2), the adverse effect on heat transfer caused by the rod displacement is most severe, if the P/D ratio of a rod bundle is in the vicinity of 1.11. A different trend is found for boundary condition (1), for which such an effect tends to diminish continuously as the P/D ratio is reduced from 1.9 toward 1.0. (10 references) (auth)

35638 VELOCITY AND TEMPERATURE DISTRIBUTION IN TURBULENT FLOW IN SODIUM COOLED FUEL ELEMENTS WITH ECCENTRIC GEOMETRY. Hofmann, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 69-75 of Liquid-Metal Heat Transfer and Fluid Dynamics. /Chen, John C. (ed.). New York; American Society of Mechanical Engineers (1970).

From liquid metal heat transfer and fluid dynamics meeting; New York, N. Y. (30 Nov 1970).

A theoretical analysis of the velocity and temperature distribution in symmetrical and asymmetrical triangular rod clusters is presented. The analysis is applied to sodium as coolant with fully developed turbulent flow. Coolant mixing is taken into account by correlations for the diffusivities of momentum and energy. The thermal heat flux at the surface of the fuel pin is assumed to be uniform in circumferential direction and an arbitrary function in axial direction. The analysis is restricted to clusters of bare rods without spacers. Numerical results for the velocity and temperature distribution are presented for specific cases (i.e., for a rod bundle with pitch-to-diameter ratio 1.21 and deviations $\xi = 0$; 0.1; 0.2 mm). The results show that already small deviations of the fuel rod in a tightly packed rod bundle cause considerable velocity and temperature differences of the coolant around the rod, also in sodium cooled fuel elements. (8 references) (auth)

35639 NUCLEAR FUEL ASSEMBLY ALIGNMENT STRUCTURE. Normand, G.; Venobre, H. (to Commissariat a l'Energie Atomique). Canadian Patent 889,546. 28 Dec 1971. Priority date 31 Jan 1968, France.

A nuclear fuel assembly which is vertically positioned in a reactor core, and which can be inserted and withdrawn by vertical displacement, is provided with means for producing the automatic orientation of each assembly when it is inserted in a core location. A central portion of polygonal cross-section having symmetry of revolution forms the major part of the length of the assembly. One of the end portions is of smaller cross-sectional area than the central portion and is provided with longitudinal lugs which form cams with bevelled edges and which are disposed in the line of extension of the ridges of the normal cross-section. The other end portion has a V-shaped ramp at the extremity of each face of the assembly, giving a bearing surface for the bevelled edges and guiding the lugs toward the vertices of the polygonal cross-section. This automatic orientation system has an appreciable advantage over comparable systems in that the flow of coolant is not disturbed. (Canada)

35640 METHOD AND APPARATUS FOR FUELLING A PRESSURISED NUCLEAR REACTOR. Whittaker, S. J. (to Atomic Energy of Canada Ltd.). Canadian Patent 891,193. 19 Jan 1972.

A nuclear reactor fuel channel which extends horizontally and has a flap valve sealing the fuel channel is fueled by means of a fueling machine comprising a casing, a driven endless conveyor within the casing, a fuel stringer engaging various means on the conveyor, a rotatable ram having an inclined end face, and means for rotating the ram when it has opened the flap so that the inclined end face is turned away from the flap valve. By attaching the fueling machine to a pressurized fuel channel the ram may be advanced to open the flap valve, rotated, and then retracted to allow a spent fuel stringer to be moved out of the fuel channel by the coolant flow until the fuel stringer is engaged by the engaging means and hauled on to the conveyor. (Canada)

35641 PRESSURE TUBE REACTOR FUEL BUNDLE. Desbois, G. P. (to Combustion Engineering-Superheater Ltd.). Canadian Patent 887,895. 7 Dec 1971.

Spacing between the fuel rods in a bundle, and between the outer-most fuel rods and the guiding or pressure tube at the midpoint, is provided by an arrangement of continuous narrow thin strips of semi-rigid material formed into generally closed loops. These strips maintain pressure contact with the fuel rods and are deformed at locations corresponding generally to the points of minimum distance between the fuel rods and between the outer fuel rods and the guiding tubes. The spacing arrangement is maintained at the bundle midlength position by filaments fastened at one end to the spacing arrangement and at the other end to either the thick end cap or the fuel rods or to the end plate of the bundle. In order to provide at least a three point support between the fuel bundle and the guiding tube, the filament follows a generally helical path between the end of the fuel bundle and the spacer so that it crosses over at least one of the outermost fuel rods. The thickness of the filament then determines the minimum spacing between the fuel rod and the guiding tube. This arrangement avoids the need for fastening any attachment to the thin wall of the fuel element sheaths, eliminating the risk of damaging or impairing the integrity of the fuel sheath. Other advantages are the use of a minimum amount of neutron absorbing material, reduction in manufacturing cost, and adaptability to variations in bundle design. (Canada)

35642 EFFECTIVENESS OF CONTROL RODS PARTIALLY INSERTED INTO A REFLECTED REACTOR. Amano, Fumio (Electrotechnical Lab., Tokyo); Inoue, Shuji; Akino, Fujiyoshi. J. Nucl. Sci. Technol. (Tokyo); 9: No. 4, 224-36(Apr 1972).

A method is described for evaluating the effectiveness of cylindrical control rods for the general case where multiple control rods of various effective lengths affecting epithermal and thermal neutrons are arbitrarily distributed and partially inserted to mutually independent positions in a reflected reactor. This method is a generalization of the technique introduced by Nordheim and Scalettar (N–S method), employing the two-group, three-dimensional diffusion theory with modified application of the boundary condition imposed on the surface of control rods. Either the multiplication constant or the prompt neutron decay constant can be designated as eigenvalue of the system. Moreover, vector-matrix notations are employed to facilitate the treatment of the problems and the subsequent derivation of the critical determinant. The general problem based on the asymmetrical arrangement of control rods can be reduced to a number of special cases to find out the order of the critical determinant. The limitations of the modified N–S method are discussed. Calculated results are compared with experimental data based upon the pulsed neutron source method. (43 references) (auth)

35643 ANALYTICAL PROBLEMS ASSOCIATED WITH CORE SUPPORT STRUCTURE OF PWR. Boehm, George J. (Westinghouse Electric Corp., Pittsburgh). Nucl. Eng. Des.; 18: No. 2, 305-21(1972). (CONF-710903–23).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

The design of core support structures of a pressurized water reactor requires the solution of structural problems with a degree of sophistication that is not usual to other types of power generating plants. This situation arises not only from the complexity of both the structures and the external loads, but also from safety specifications requiring a precise knowledge of component behavior. The analytical problems derived from normal and abnormal operation cover a wide range of static and dynamic problems. Extensive use of modern, high-speed computing tools is required to solve these problems. Linear and nonlinear analyses for static and dynamic problems use computer programs of varied complexity, leading to the use of newly developed techniques in the area of finite elements and numerical stability of integration methods. The existing type of analytical problems faced in design and the methods used to solve them are reviewed. (43 references) (auth)

35644 TEMPERATURE AND STRESSES IN REACTOR FUEL ELEMENTS DUE TO TIME- AND SPACE-DEPENDENT HEAT-TRANSFER COEFFICIENTS. Holy, Z. J. (Univ. of New South Wales, Kensington, Australia). Nucl. Eng. Des.; 18: No. 1, 145-97(1972). (CONF-710903–18).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

Various methods are discussed and compared for the prediction of temperature and thermoelastic stress fields in nuclear reactor fuel elements and other components due to both steady and transient non-uniform surface heat transfer. A general mathematical outline of the problem is given, with the sphere and infinite half-space of constant properties considered in detail. For a number of heat-transfer distributions results for temperatures and stress components obtained by various methods are presented. It is concluded that significant temperature and stress increases due to non-uniform heat-transfer variation must be taken into account in the design of nuclear reactor components. (22 references) (auth)

Reactor Physics and Core Engineering

Physics

Refer also to abstract 35401.

35645 (AEEW-M–355) SOLUTION OF EQUATIONS ARISING FROM THE USE OF COLLISION PROBABILITIES. Pull, I. C. (Atomic Energy Establishment, Winfrith (England)). Aug 1963. 13p. Dep. NTIS (U. S. Sales Only).

An expression of energy-dependent neutron transport in terms of collision probabilities is derived. A method of solution of the resulting equations is proposed. (5 references) (auth)

35646 (AEEW-M–1026) INVESTIGATIONS INTO SOLVING THE NEUTRON DIFFUSION EQUATION OVER A TWO-DIMENSIONAL DOMAIN. Green, C. (Atomic Energy Establishment, Winfrith (England)). Nov 1971. 29p. Dep. NTIS (U. S. Sales Only).

An attempt has been made to devise methods of solving the finite difference approximation to the neutron diffusion equation over a two-dimensional domain (in particular XY and RZ geometries). The methods tried used a channel-by-channel method of solution, whereas many methods employ the group-by-group approach. The investigation was not completely successful for the general problem, although some success was evident for full scatter problems. The numerical methods employed are described and certain results are included. (UK)

35647 (ANL–7925) APPLICATIONS OF FINITE ELEMENT METHODS IN REACTOR MATHEMATICS. NUMERICAL SOLUTION OF THE NEUTRON DIFFUSION EQUATION. Kaper, Hans G.; Leaf, Gary K.; Lindeman, Arthur J. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 99p. Dep. NTIS.

The applicability of a particular class of high-order approximation procedures for the numerical solution of the multigroup neutron diffusion equation on two-dimensional reactor configurations is investigated. This class is based on the use of variational principles and finite-dimensional subspaces whose elements are piecewise polynomial functions obtained by a Lagrange-type interpolation procedure over a triangulation of the domain (finite element method). On the basis of a research High Order Diffusion computer program (HOD) each approximation procedure is evaluated and its performance is compared with that of a low-order approximation procedure based on the use of finite difference methods, for the computation of neutron distributions and inventories in reactor design studies. 16 references. (auth)

35648 (BNL–16727) ROD AND SCRAM BANK SIMULATION. Lellouche, Gerald S. (Brookhaven National Lab., Upton, N. Y.). Aug 1971. 35p. (RP–1018). Dep. NTIS.

A simple method of predicting the reactivity change of a reactor core during safety rod ejection or scram bank insertion is derived. The method is used to calculate the power/time and temperature/time response due to rod motion. (H.D.R.)

35649 (DP–1239) XENON OSCILLATION CALCULATION BY MODAL ANALYSIS. Randall, D. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Mar 1972. Contract AT(07-2)-1. 44p. Dep. NTIS.

A one-dimensional, one-group modal analysis treatment of xenon spatial oscillations is presented. The one-dimensional, one-group diffusion theory flux distribution equation and the equations for the rates of formation of iodine and xenon are solved with the usual linearization technique. Time derivatives are eliminated by assuming that the perturbations vary exponentially with time. The solution yields threshold reactor-average fluxes (if any) and corresponding oscillation periods at threshold, periods of oscillations (if any; whether growing or decaying), perturbation flux amplitude ratios, and damping factors at any specified reactor-average flux levels. Centrally flattened (to any extent) fundamental fluxes, sinusoidal for the axial case or J_0 for the radial case, are permitted, and the effect of a temperature coefficient may be included. (3 references) (auth)

35650 (ORNL-tr–2605) ROSSI-ALPHA-EXPERIMENT BY THE STOPWATCH METHOD. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of Chapter 13 of report INR–4/66-5. 6p. Dep. NTIS.

A reactor noise experiment is described in which the so-called stopwatch technique is used. In this technique only a limited number of detector signals are used to determine a correlation function for the two detectors. (H.D.R.)

35651 (ORNL-tr–2606) NOISE/SIGNAL RATIO IN THE LIMIT CASE OF NEUTRON CHAINS WITH TIME SEPARATION. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of Chapter 14 of report INR–4/66-5. 5p. Dep. NTIS.

35652 (ORNL-tr–2607) NOISE/SIGNAL RATIO IN MORE GENERAL CASES OF THE ROSSI-ALPHA-EXPERIMENT. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of Chapter 15 of report INR–4/66-5. 8p. Dep. NTIS.

35653 (ORNL-tr–2608) NOISE/SIGNAL RATIO AT SMALL αT_0 VALUES EXPERIMENTAL RESULTS. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of Chapters 16 and 17 of report INR–4/66-5. 8p. Dep. NTIS.

For short-term considerations and for compact nearly-critical reactors, the prompt-kinetic approximation of the point source model is applicable. This model was used to investigate different types of correlation experiments which measure the prompt time constant α. (H.D.R.)

35654 SYNTHESIS OF THREE-DIMENSIONAL TRANSPORT PROBLEMS USING TWO-DIMENSIONAL TRIAL FUNCTIONS. Natelson, M. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng.; 48: No. 1, 16-27(May 1972).

Two schemes are proposed in which solutions to the three-dimensional transport equation can be synthesized from two-dimensional transport solutions. Derivations are presented which employ a weighted residual technique applied to the second order (even parity in the direction vector Ω) form of the transport equation. Numerical testing indicates that for problems in which transport effects are restricted to the trial function planes, where synthesis axis leakage can be described by diffusion theory, the transport synthesis schemes perform very well. (auth)

35655 ACCURACY OF COARSE GROUP CALCULATIONS IN FAST REACTORS. Antonakas, D.; Corcuera, R.; Govaerts, P. (CEN, Cadarache, France). Nucl. Sci. Eng.; 48: No. 1, 1-9(May 1972).

Fast reactor parameters are compared as obtained either by a detailed fine group calculation where the scattering resonances of light and intermediate elements are well accounted for, or by coarse group calculations (~25 groups). These fundamental mode calculations are performed with cross sections derived from the same basic data in order to check only the approximations of the calculational methods. The parameters considered are k, B_m^2, $\bar{D}$, one-group cross sections, danger coefficients, and the spatial heterogeneity effect. The properties which can be reliably evaluated with few groups are indicated. The fine group calculations are performed with the PROMETHEE code developed at Cadarache, using a $^1/_{120}$ lethargy mesh (usually about 2000 groups). (20 references) (auth)

35656 GENERALIZED MODEL FOR THE ELASTIC AND INELASTIC SLOWING DOWN OF FAST NEUTRONS. Rocca-Volmerange, B. (Paris Univ., Orsay, France). Nucl. Sci. Eng.; 48: No. 1, 10-15(May 1972).

For the determination of fast neutron spectra, a slowing down operator model is proposed whose number of terms increases with the needed accuracy without theoretical limit. This method can be used for elastic and inelastic slowing down and needs only the choice of an arbitrary fitting flux and the determination of some functions from this flux. Applications to the determinations of spectra and reaction rates are studied in various media including resonant elements. The practical interest of this method is its rapid convergence. (auth)

35657 EXTENSION OF LINEARLY ANISOTROPIC ASYMPTOTIC NEUTRON DIFFUSION THEORY TO REFLECTED SYSTEMS. Koponen, B. L.; Doyas, R. J. (Univ. of California, Livermore). Nucl. Sci. Eng.; 48: No. 1, 115-19(May 1972).

The extension of asymptotic diffusion theory to reflected systems by applying discontinuous half-space boundary conditions is demonstrated. Critical size calculations for two-region infinite planes, spheres, and infinite cylinders show significant improvement over standard diffusion theory calculations with continuity boundary conditions. (12 references) (auth)

35658 SCATTERING MATRIX CONSTRUCTION FOR THE DISCRETE ENERGY REPRESENTATION OF THERMAL-NEUTRON SPECTRA. Matausek, M. V. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Sci. Eng.; 48: No. 1, 119-21(May 1972).

The method of discrete energy representation of thermal-neutron spectra was improved by a simple and efficient procedure for deriving multipoint equations and constructing the scattering matrix. The procedure was numerically examined on a number of reactor cell configurations with satisfactory results. (auth)

35659 PULSED-ACTIVATION TECHNIQUE FOR HIGH-TEMPERATURE DOPPLER MEASUREMENT IN NUCLEAR FUELS. Lucoff, David Michael. Madison, Wis.; Univ. of Wisconsin (1972). 203p. University Microfilms Order No. 72-4286.

Thesis.

The Doppler effect is one of the important mechanisms for introducing negative reactivity feedback into a nuclear reactor. For a transient over-power in a ceramic fueled power reactor, the Doppler feedback occurs in the fuel which is at high temperatures, usually greater than 1500°K. In order that the Doppler effect at high temperature can be predicted with confidence, experiments measuring the Doppler effect in nuclear fuels at high temperatures must be performed. The Doppler effect in $^{238}UO_2$ has been measured in the temperature range from 300 to 2160°K in both thermal reactor and fast reactor spectra, but limitations in furnace technology have prevented measurements at higher temperatures. In order to measure the Doppler effect above 2160°K, a new approach is proposed, the pulsed-activation Doppler (PAD) technique. In the PAD technique, a small fissile-enriched sample of resonance material is irradiated in a pulsed reactor. The sample is heated adiabatically with fission energy. Resonance absorption occurs in the sample concurrently with the pulsed heating. The Doppler effect is measured by comparing the amount of resonance activation in the heated sample with that in an unheated sample. PAD experiments with U-metal and UO_2 were performed in the Triga reactor at the University of Wisconsin. An irradiation cell was designed to hold the samples in a fixed core position during the pulsed irradiation. A least-squares fitting program was used to analyze the resulting gamma-ray spectrum of the irradiated sample to determine its resonance activation and fission product inventory. The resonance activation in the heated sample was corrected for thermal activation and then compared to the activity of a cadmium-wrapped sample. The fractional change in resonance activation due to the Doppler effect and sample expansion was deduced from the ratio of the resonance activation in the heated sample to that of the unheated sample. This quantity was corrected for expansion effects to yield the fractional change in resonance activation due to the Doppler effect. The energy deposition was determined with a thermocouple-instrumented sample and the equation of state. The specific activity of the fission products associated with that sample was used to calibrate the energy deposition for all experiments. A method of analysis was developed which combines the equation of state and a Doppler effect model for the sample material to predict the fractional change in resonance activation for the heated sample. The results of the experiments with U-metal and the results for UO_2 with energy depositions below 125 cal/gm (a peak UO_2 sample temperature of 2000°K) were in agreement with predictions and were consistent with generally accepted low-temperature models of the Doppler effect. The results of PAD experiments which approached the melting point of UO_2 (3115°K) were above the predicted values. Four possible explanations for this discrepancy are given: (1) pellet cracking during heating, (2) radiative heat transfer from the sample during heating, (3) improper value of the parameter in the Doppler model, (4) improper correction for the thermal flux depression in the sample. It was concluded that the results of the low temperature experiments validate the PAD technique. (Diss. Abstr. Int., B)

35660 EFFECT OF HIGHER ORDER ANISOTROPY ON DISADVANTAGE FACTOR IN A CELL. Takeda, Toshikazu; Azekura, Kazuo; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 4, 249-50(Apr 1972).

35661 FAST REACTORS. II. Debrue, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Rev. Quest. Sci.; 143: No. 1, 87-107(1972). (In French).

35662 FAST REACTORS. I. Debrue, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Rev. Quest. Sci.; 142: No. 4, 539-56(1971). (In French).

The basic physics principles of fast reactors are described. The natural technological and nuclear constraints on the present fast reactor concepts and projects are discussed. (tr-auth)

35663 ON-LINE DETERMINATION OF TIME-VARIANT REACTIVITIES USING A PROCESS COMPUTER. Ziegler, W. (Siemens AG, Erlangen, Ger.). Atomkernenergie; 19: No. 3, 245-52(May 1972). (In German).

The analog computing techniques for evaluation the reactivity of nuclear reactors are tested, how far they are adaptable for applying digital techniques. Using the blockoriented language ANAGOL systematic errors and noise sensitivities can be easily investigated. Neutron history, noise filtering and the automatic compensation of scale changes in the linear channel of neutron detection must be considered before programming of a process computer (SIEMENS 305) for on-line determination of time-variant reactivities. The given background allows to build up a digital reactimeter. (30 references) (auth)

Core Thermal Hydraulics

35664 PARALLEL-FLOW-INDUCED VIBRATION OF FUEL RODS. Chen, Shoei-sheng; Wambsganss, Martin W. (Argonne National Lab., Ill.). Nucl. Eng. Des.; 18: No. 2, 253-78(1972). (CONF-710903-21).

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

A mathematical model is proposed to describe the phenomena of parallel-flow-induced vibrations of a flexible rod, and a solution is obtained for a rod with arbitrary end conditions; the solution can be used for fixed, hinged, cantilevered, and other elastically supported end conditions. Comparisons between model predictions and flow-test data for rods with fixed and cantilevered end conditions show that the model successfully predicts the essential features of the system behavior: (1) the adjacent rods and duct wall may considerably increase the added mass; (2) the fundamental frequency may increase or decrease with flow velocity, depending on the end conditions; (3) the system damping increases with increasing flow velocity, and is attributed to the normal drag force and the Coriolis acceleration; (4) the rms rod response increases with flow velocity and follows an approximate power function relationship; and (5) the increase in rigidity at the ends tends to reduce the rms response. (37 references) (auth)

GENERAL

Civilian Defense

35665 (INIS-mf–208) INTERNATIONAL NUCLEAR INFORMATION SYSTEM. Pelzer, C. W. (International Atomic Energy Agency, Vienna (Austria)). 10 Oct 1971. 20p. (CONF-711042–1). INIS.

From forty-fifth annual conference of Aslib; Darmstadt, Germany (10 Oct 1971).

The International Nuclear Information System (INIS) is described, beginning briefly with the history of its development, basic assumptions and the selection of the Thesaurus. The startup activities and the preparation of the INIS Reference Series, the organization and staffing, the equipment requirements, the production and operating experience (including input and output problems of the participating Member States and International Organizations as well as the IAEA), and operating costs are discussed. The relationship with participating Member States and International Organizations is described, including the system for securing and exchanging ideas for improvements, the use of advisory committees, working groups and on-the-job training, and training seminars. A summation of problems to be solved, potential improvements and additions, an evaluation of the system to date, and a forecast for the future are given. (INIS)

Law

Refer also to abstracts 33382, 33534, and 33536.

35666 (AEEW-M–1057) DAP-16 ASSEMBLY ON AN ICL 4-70 FOR HONEYWELL H316 COMPUTERS. Darwall, G. H. D. (Atomic Energy Establishment, Winfrith (England)). Nov 1971. 15p. Dep. NTIS (U. S. Sales Only).

DAP-16 symbolic assembly language programs destined to run on Honeywell H316 computers are now assembled on the Winfrith ICL 4-70. The use and structure of the 4-70 assembler are described. The program has subsequently been converted to run on the Harwell 360/75 computer. (auth) (UK)

35667 (EUR–4606) MEDICAL ATLAS OF RADIONUCLIDES USED IN MEDICINE, BIOLOGY, INDUSTRY, AND AGRICULTURE. Simon, S. (Brussels Univ. (Belgium)). 1971. 374p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 300,-.

This atlas of radionuclides is intended for small and medium-sized users of radioactive substances. For each of the chemical elements, grouped according to the Mendeleev classification, it supplies the documentation necessary for the use of their various radioisotopes currently employed, while guaranteeing adequate protection of workers. This documentation is scattered throughout official texts and scientific literature and is generally difficult to find. The atlas is so designed that each chapter constitutes an independent whole. For each nuclide and for its various possible radioisotopes the atlas supplies the radiophysical characteristics, the biological behavior in man in relation to the standard man, with details of the critical organs and modes of elimination, the protection measures, with details of radiotoxicity and the maximum doses prescribed in the Euratom Standards for radiological protection, possible uses in medicine, biology, agriculture, industry, etc., together with methods of disposal of waste. For industrial doctors responsible for radiation protection the atlas provides documentation dealing with specific decontamination measures, together with methods of detection when these extend beyond the scope of conventional dosimetry. (126 references.) (auth)

35668 FOOD AND DRUGS. THE FOOD (CONTROL OF IRRADIATION) (AMENDMENT) REGULATIONS, 1972. Statutory Instrument No. 205. London; Her Majesty's Stationary Office (1972). 2p. 3 pence.

These Regulations amend the Food (Control of Irradiation) Regulations 1967, as amended by the Food (Control of Irradiation) (Amendment) Regulations 1969, by increasing the low level of irradiation that is permitted under the regulations from 10 to 50 rad., and revoke the Food (Control of Irradiation) (Amendment) Regulations 1969. (UK)

35669 SPECIAL INTEREST. The Atomic Energy Commission, Argonne National Laboratory, and the Midwestern Universities. Greenbaum, Leonard. Ann Arbor, Mich.; University of Michigan Press (1971). 238p. $10.00.

ANL is administered by a unique tripartite contract between a consortium of universities as policy-makers, the University of Chicago as manager, and the AEC. The history of how this contractual arrangement came into being is recounted. It is divided chronologically into the three organizational arrangements which preceded the present Argonne Universities Association: The Board of Governors of Argonne National Laboratory, 1946–1950; The Executive Board of the Council of Participating Institutions, 1950–1958; and The Board of Directors of Associated Midwest Universities, 1958–1968. (R.W.R.)

Miscellaneous

35670 (AEC-tr–7102/2) NUKLEONIKA. Translation of Nukleonika; 15: No. 2, 145-236(1970). 80p. (TT–70-55010/2). Dep. NTIS.

35671 (AEC-tr–7311) SULFUR ISOTOPE STUDIES ON NORWEGIAN AND GERMAN IRON PYRITE DEPOSITS. Anger, Gerhard. Translated from Ber. Geol. Ges. Deut. Demokrat. Repub. Gesamtgeb. Geol. Wiss.; 9: 543-9(1964). 11p. Dep. NTIS.

35672 (AECL–4129) AECL RESEARCH IN ENGINEERING. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Winter 1972. 18p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

35673 (ANL–7808) LIBRARY BOOK ACQUISITION AND TECHNICAL REPORT ORDERING SYSTEM. Harrison, Charles Jr.; Snow, William J. (Argonne National Lab., Ill.). Feb 1972. Contract W-31-109-eng-38. 56p. Dep. NTIS.

35674 (ANL-Trans–913) ELECTRODISCHARGE MACHINING. Translated for Argonne National Lab., Ill., from VDI (Verein Deutscher Ingenieure) Richtlinien 3400. 19p. Dep. NTIS.

35675 (AWRE-O–47/71) RESPONSE OF ELECTRICALLY SHORT CABLES TO TRANSIENT ELECTROMAGNETIC FIELDS. Oats, R. (Atomic Weapons Research Establishment, Aldermaston (England)). Aug 1971. 55p. Dep. NTIS (U. S. Sales Only). UK 37 pence.

35676 (BDX–613-289(Rev.)) REINFORCED COMPOSITE CASE, FY70-4. Quarterly Report. Fotopoulos, C. U. (Bendix Corp., Kansas City, Mo.). Jan 1972. Contract AT(29-1)-613. 25p. Dep. NTIS.

35677 (BDX–613-303(Rev.)) HIGH TEMPERATURE THERMAL INSULATION. Quarterly Report, FY70-4. Fotopoulos, C. U. (Bendix Corp., Kansas City, Mo.). Sep 1971. Contract AT(29-1)-613. 34p. Dep. NTIS.

35678 (BDX–613-393(Rev.)) DEVELOPMENT OF ELASTOMER CUSHIONS, FY71-3. Quarterly Report. Edman IV, G. W. (Bendix Corp., Kansas City, Mo.). Oct 1971. Contract AT(29-1)-613. 19p. Dep. NTIS.

35679 (BDX–613-562(Rev.)) MECHANICAL AND PHYSICAL PROPERTIES OF ORGANIC FOAMS. Final Report. Lormis, F. E. (Bendix Corp., Kansas City, Mo.). Feb 1972. Contract AT(29-1)-613. 60p. Dep. NTIS.

35680 (BNL–16706) MAGNETISM IN ONE AND TWO DIMENSIONS. Blume, M. (Brookhaven National Lab., Upton, N. Y.). [1971]. 19p. (CONF-720304–7). Dep. NTIS.

From fifth IAEA symposium on neutron inelastic scattering; Grenoble, France (6 Mar 1972).

35681 (CEA-CONF–1970) COMPUTER PROGRAM FOR SOLUTION OF DIFFUSION EQUATIONS FOR TWO IMPURITIES. Monnier, J.; Maffei, M.; Stern, M.; Vandorpe, D. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 27 Oct 1971. 44p. (In French). (CONF-711011–2). Dep. NTIS (U. S. Sales Only).

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For each entry in this bibliography, the author(s), complete title of the article, and journal citation or other reference are given. All are grouped according to the particular aspect of luminescence involved. Author indices are included in both parts.

The title of each article is reproduced in its original language, and after the remainder of the citation, the title is rendered in Russian. Part 1 includes only articles on photoluminescence and articles of general character. Part 2 of the bibliography includes all articles that bear upon luminescence with the exception of photo-excitation, and luminescence applications. Luminescence analysis, cathode and x-ray shields, scintillation counters, and luminescent lamps are excluded. (K.S.W.)

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Germanic	ü	ue
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Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Technical Information Center* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are the names of specific materials, things, and processes. Each heading is followed by a modifier that describes the properties of, or processes applied to, that heading.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MESONS
MESONS (π)
MESONS (rho)
1-PENTANOL
2-PENTANOL
URANIUM OXIDES
URANIUM OXIDES UO_2

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—*sorption by charcoal,* should be read *hydrogen sorption by charcoal.* As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—*yields in radiolysis of ethyl ether, effects of deuterium on,* should be read *effects of deuterium on formaldehyde yields in radiolysis of ethyl ether* and URANIUM—*crystal structure of, effect of cooling rate on allotropic transformations in,* should be read *effect of cooling rate on allotropic transformations in crystal structure of uranium.*

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Complex organic compounds occur in such variety as to require a systematic nomenclature. Headings for most substituted organic compounds are found in an inverted form following names of the parent compounds. Examples of two such headings are:

```
2,4-HEPTANEDIONE
2,4-HEPTANEDIONE, 1-PHENYL-
```

Headings are included for broad class names of enzymes, e.g., HYDROLASES and TRANSFERASES. Specific enzyme names are to be found in modifiers under these headings. Similarly, broad class names for hormones are included as headings, except in this case the headings are entered in the inverted form as, e.g., HORMONES, ADRENAL and HORMONES, SEX. The more specific names of hormones are to be found in the modifiers under the appropriate broad headings.

For compounds used as drugs, an effort is made to use subject headings that reflect the recommendations of the USAN (United States Adopted Names) compilation or the "New Names" columns of the *Journal of the American Medical Association.* The *Merck Index* has also been used in selecting subject headings for drugs.

Nomenclature of Life Sciences

Except for those in the phylum Tracheophyta, subject headings for plants are common names. For example, ALGAE, FUNGI, SLIME MOLDS, MOSSES, and LIVERWORTS are subject headings. The phylum name TRACHEOPHYTA and several classes and subclasses belonging to it are entered as subject headings. The specific classes entered are PSILOPSIDA, LYCOPSIDA, SPHENOPSIDA, and PTEROPSIDA. The three subclasses FILICINIDAE, GYMNOSPERMIDAE, and ANGIOSPERMIDAE which belong under Pteropsida are also subject headings. Scientific names (genus and species) and common names if known are used in the modifying phrase.

Subject headings for microorganisms are VIRUSES, RICKETTSIA, and BACTERIA. The name of the type or kind of virus or the genus and species names of the organisms should appear in the modifying phrase.

The names of animal phyla are subject headings. The arthropods are also indexed to subject headings for classes INSECTA, CRUSTACEA, ARACHNIDA, DIPLOPODA, and CHILOPODA. The invertebrate chordates are indexed to subject headings UROCHORDATA and CEPHALOCHORDATA. The vertebrates are indexed to headings for the classes AGNATHA, CHONDRICHTHYES, OSTEICHTHYES, AMPHIBIA, REPTILIA, AVES, and MAMMALIA as well as to the general heading VERTEBRATA. Common names are used as subject headings in the class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are common names such as ANEMIA, FIBROSIS, INFECTIONS, LEUKEMIA, NEOPLASMS, and RADIATION SICKNESS. Also, the general headings DISEASES and DISEASES, PLANTS are available as subject headings.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except those with well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

LEAD TITANATES
$PbTiO_3$--$PbZrO_3$
LEAD ZIRCONATES
$PbTiO_3$--$PbZrO_3$

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
acetic acid--BF_3, ...
BORON FLUORIDES
acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
bromophenol--chlorobenzene, ...
PHENOL, BROMO-
bromophenol--chlorobenzene, ...

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
Al_2O_3--Cu, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
deposition on nuclear fuel particles
molecular structure of
neutron total cross section for
sorptive properties for xenon
Young's modulus for
Al--C--Cr, superconductivity in
B--C, phase studies for
C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of the Particle Data Group published in *Review of Particle Properties* (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: $\Lambda\text{-He}^5$, $\Sigma\text{-H}^3$, $\Lambda\Lambda\text{-Be}^{10}$. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
interactions $\pi^- + p \to \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, $\Lambda K(1700)$ enhancement in, (E)
BARYONS, RESONANCE (Δ)
production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \to K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERNUCLEI
binding energy of $\Lambda\Lambda\text{-He}^6$, three-body α--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS
quark, hadron total cross sections in, numerical analysis of
CURRENT ALGEBRA
PCAC hypothesis for A_1 and rho dominance in $\pi \to e + \nu + \gamma$ decay
REGGE POLE THEORY
predictions for polarization in $K^- + p \to$ anti $K^0 + n$, $\pi^- + p \to \pi^0 + n$, and $\pi^- + p \to$ eta + n interactions at high energies
SYMMETRY GROUPS
SU(2) x SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (2) or (3) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

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Reports, conference papers and proceedings, numbered translations, and patents are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show which reports are on file in the institutions listed on the back of the front cover (Dep.), which reports have been published in open-literature journals (journal citation), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, the availability is given under the primary number, and a cross reference is given under the secondary report number.

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CONF-690814-	(11th International Conference on Cosmic Rays, Budapest, Hungary, Aug. 25-Sept. 4, 1969)	
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1	26-33325	See PNC-N-831-70-2, pp 85-8
2	26-33813	See PNC-N-831-70-2, pp 89-90
3	26-33342	See PNC-N-831-70-2, pp 91-8
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2	26-35683	See CEA-CONF-1985
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2	26-33848	See PNC-N-831-70-2, pp 15-34
3	26-33849	See PNC-N-831-70-2, pp 35-45
4	26-33850	See PNC-N-831-70-2, pp 46-8
5	26-33851	See PNC-N-831-70-2, pp 49-53
6	26-33852	See PNC-N-831-70-2, pp 54-8
7	26-33301	See PNC-N-831-70-2, pp 59-64
8	26-33895	See PNC-N-831-70-2, pp 65-9
9	26-33245	See PNC-N-831-70-2, pp 73-4
10	26-33246	See PNC-N-831-70-2, pp 75-6
11	26-33247	See PNC-N-831-70-2, pp 77-8
12	26-33092	See PNC-N-831-70-2, pp 79-83
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18	26-35582	See IAEA-130, pp 73-85
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20	26-35595	See IAEA-130, pp 285-94
21	26-35585	See IAEA-130, pp 139-43
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4	26-34332	See TRITA-EPP-71-29
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23	26-35643	Nucl. Eng. Des.; 18: No. 2, 305-21(1972)
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	26-35050	See RISO-250
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2	26-35681	See CEA-CONF-1970
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1	26-35665	See INIS-mf-208
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	26-34966	See NCSAC-42
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1	26-35731	See RLO-2225-T-21-4
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1	26-33604	See BNL-16663
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1	26-33321	See UCRL-73747
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5	26-35705	See JINR-E14-6266
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7	26-35680	See BNL-16706
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1	26-35686	Dep. NTIS, 21p.
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2	26-35185	Dep. NTIS, 17p.
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233	26-35481	Dep. NTIS, 1p.
234	26-35506	Dep. NTIS, 152p.
235	26-35482	Dep. NTIS, 4p.
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92	26-35511	Dep. NTIS, 4p.
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50	26-35521	Dep. NTIS, 87p.
51	26-35522	Dep. NTIS, 167p.
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44	26-35529	Dep. NTIS, 39p.
45	26-35530	Dep. NTIS, 252p.
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50	26-35521	See DOCKET-50295-50
51	26-35522	See DOCKET-50295-51
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DOCKET-50316-	(Donald C. Cook Nuclear Power Plant, See also DOCKET-50315) (Non-AEC)	
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DOCKET-50333-	(James A. Fitzpatrick Nuclear Power Plant) (Non-AEC)	
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44	26-35537	Dep. NTIS, 4p.
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37	26-35539	Dep. NTIS, 12p.
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24	26-35541	Dep. NTIS, 47p.
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